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ENERGY AND TIME BETA RAY SPECTRA OF FISSION PRODUCTS OF U^{235} BY FISSION NEUTRONS AND U^{238} BY 14 MEV NEUTRONS

Robert B. Heller

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Robert B. Heller

16 February 1961

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ENERGY AND TIME BETA RAY SPECTRA OF FISSION PRODUCTS OF U^{235} BY FISSION NEUTRONS AND U^{238} BY 14 MEV NEUTRONS[1/]

INTRODUCTION

The primary purpose of this memorandum is to provide a practical estimate of the beta ray spectrum from fission products at short times after fission.

The machine program developed to furnish this information automatically provides the spectrum for later times at very little additional effort, together with the distribution of beta radiation by specific nuclides.

This information has been developed and is presented in this memorandum for 14 MEV neutron fissioning of U^{238} and also for U^{235} fissioned by fission neutrons.

METHOD

The disintegration rate $\beta_j(t)$, for the j^{th} fission fragment of a chain was generated by solving the differential equation for the decay chain and computing the activity $\beta_j(t)$ at a series of times t.

1/ Acknowledgement is made of the valuable assistance given to me by Dr. George E. Pugh, Miss Joanna Frawley, Mrs. Elaine Marcuse, and Mrs. Juanita Price in the development and calculations needed for this paper.

$\beta_j(t)$ was then multiplied by a function $\rho_j(E)$ which gives the probability that the decay yields a beta ray with kinetic energy E. The product $\beta_j(t)\rho_j(E)dE$ gives the number of beta rays at a given energy and time from the j^{th} isotope, in the energy range between E and $E + dE$.

The product $\beta_j(t)\rho_j(E)$ was summed over all known or postulated members of a specific fission chain with mass number A. This yields

$$\sum_j \beta_j(t)\rho_j(E). \qquad (1)$$

If the above expression is then summed over all fission chains with mass numbers from about 72 to 162, the complete energy and time function is obtained for the beta activity from fission.

$$\beta(E,t) = \sum_A \sum_j \beta_j(t)\rho_j(E) \qquad (2)$$

INPUT DATA

The complete summation expressed in equation (2) requires input data of two general categories; they are:

a. The initial fission abundance of the isotopes by chain mass number A and by charge distribution Z within the chain A. This, plus the decay time constants, suffice to calculate $\beta_j(t)$.

b. The beta ray end point energy E_o plus the forbidden degree of the beta transition. These factors enable the calculation of the probability function $\rho_j(E)$.

The initial mass yields from fission of U^{238} by 14.7 MEV neutrons actually used in this development were experimentally determined and reported in Los Alamos Report, LA 1997. The solid line in Figure 1 represents data taken from LA 1997. The dashed line fills in the mass yields below A = 90. These were taken from the work of J. G. Cuninghame[1] and smoothed into the Los Alamos results. Figure 2 gives the fission spectrum neutron mass yield from U^{235} fission. This curve was synthesized by altering the thermal neutron yield so that the valley fragment yields were increased to lie between capsule and 1 MEV neutron fission yields, the double peaks suppressed to lie between the known 14 MEV and thermal yields, and the wings opened to half the difference between the 14.7 MEV and thermal yields.

The distribution of nuclear charge in fission occurring within a given mass chain has been, and remains, a somewhat uncertain theoretical experimental problem.[2]

1/ J. G. Cuninghame, The Mass Yield Curve for Fission of Natural Uranium by 14 MEV Neutrons, J. Inorg. Nucl. Chem. 5, 1 (1957).

2/ For a more complete discussion see L. E. Glendenin, D. C. Coryell, and R. R. Edwards, Paper 52, p. 489, Radio Chemical Studies, The Fission Products Book 1, McGraw-Hill.

The postulate of equal charge displacement was used in this study to obtain the most probable division of charge between the two fission fragments of U^{235}. The most probable charge[1] division leads to equal $(Z_A - Z_p)$ values for the two fission fragments, where Z_p is the most probable charge for the fragment and Z_A the hypothetical charge of maximum stability for a given mass chain number A.

It was assumed that the distribution of charge around the most probable charge Z_p is symmetrical. The fraction of the total initial chain yield in any chain number Z is calculated from its $Z - Z_p$ value using Figure 52.2 on page 495 of footnote 2, page 3 of this paper.

The equal charge displacement and symmetrical distribution around this most probable charge appears reasonable in view of the experimental agreement for the observed shielded nuclides Br^{82}, Rb^{86}, Cs^{136} and Xe^{135}. The fraction of the total initial number of U^{235} fission products in various chain positions was determined using the above procedure.

1/ The most probable nuclear charge division defines, for primary fission products of a specific mass chain, the hypothetical Z_p value around which other initial members of the chain are distributed according to the various charge distribution postulates, e.g., for the equal charge displacement postulate the predicted most probable nuclear charges for primary products of masses 82 and 86 are 32.4 and 34.0.

The decay constants[1] of more than 50 percent of the possible 412 fission fragments have not been experimentally observed nor investigated. The decay schemes used by Bolles and Ballou[2] were used in the computations described herein for U^{235}. Some 202 nuclides half lives in these decay schemes have not as yet been observed but calculated values were used.

In the case of the decay constants and independent yields of U^{238} by 14 MEV neutrons the values used were those calculated by P. J. Dolan[3]. In these calculations, the most probable charge for a fission fragment of given mass was determined according to the theory of Pappas[4] as extended by Ford and Gilmore.[5]

It was necessary to assign a fraction of parent activity going to each isomer where a chain contained an isomeric pair.

1/ Latest data from D. Strominger, J. M. Hollander, and G. T. Seaborg, Rev. Mod. Phys. 30, 585 (1958).

2/ R. C. Bolles and N. E. Ballou, Calculated Activities and Abundances of U^{235} Fission Products, U.S. Radiological Defense Laboratories, USNRDL-456, 30 August 1956.

3/ P. J. Dolan, Gamma Spectra of U^{238} Fission Products at Various Times after Fission, Defense Atomic Support Agency Report 526, May 1959.

4/ A. C. Pappas, A Radiochemical Study of Fission Yields in the Region of Shell Perturbations on the Effects of Closed Shells in Fission, Laboratory for Nuclear Science, Massachusetts Institute of Technology, Technical Report No. 63, 15 September 1953.

5/ G. P. Ford and J. S. Gilmore, Mass Yields From Fission By Neutrons Between Thermal and 14.7 MEV, Los Alamos Scientific Laboratory of University of California, LA 1997, February 1956.

Most of these proportions were known from experimental determination. When lacking, isomeric activity was estimated from measured fission yield of one isomer and the total chain yield. Arbitrary ratios of 50-50 of the parent activity of Rb^{91}, In^{117}, and Cs^{119} were assigned to each daughter isomer.

THE BETA END POINT ENERGIES

Available experimentally determined beta ray end point kinetic energies were assigned to their corresponding isotopes.

For a rough prediction of the total beta decay energy Q_B of unknown nuclides or beta activity too short to have been determined, the procedure suggested by Coryell[1/] was used. (See Table I for the calculated results.) Any loss of this available energy Q_B to gamma ray transitions in the short half life unknown decays was ignored. By so doing, this report can only hope to develop an approximate upper limit for the high energy portion of the beta spectrum and for times less than 30 seconds after fission.

ALLOWED AND FORBIDDEN SPECTRA

In general, where experimentation classified the transitions as allowed or forbidden, the appropriate energy-shaping expression or correction factors were used. When experimental

1/ C. D. Coryell, Beta Decay Energetics, Annual Review of Nuclear Science, Vol. 2, 1953, p. 331, (UNCLASSIFIED).

results were lacking, the forbiddenness was chosen to agree with the Ft values of Feingold[1/] or the classification based upon the nuclear shell structure of M. G. Mayer.[2/3/]

LIMITATIONS OF THE HALF LIFE, END POINT ENERGY AND FORBIDDENNESS INPUT DATA

While it is common practice to assume 100 percent beta transition between ground states whenever experimental information is unavailable, studies by Perkins and King[4/] have shown that this simplification may lead to errors in both the beta and gamma radiation associated with fission. In their procedure, which is adjusted to be consistent with the experimentally measured total gamma energy from all the fission product decay, a single "effective" beta and gamma transition is used and adjusted to account for the mass difference between parent and daughter.

This sharing of the total energy between effective beta and gamma would result in somewhat lower beta and point energies than that used in this study. In addition, if the single "effective" beta and gamma transition recipe for unknown decays were used, a readjustment of half lives towards smaller values would result.

1/ A. M. Feingold, Table of Ft Values in Beta Decay, Review of Modern Physics, Vol. 23, 1951, pp. 10-18.
2/ M. G. Mayer and S. A. Moszkowski, Nuclear Shell Structure and Beta Decay, I. Odd A Nuclei, Review of Modern Physics, Vol. 23, 1951, pp. 315-321.
3/ L. W. Nordheim, Nuclear Shell Structure and Beta Decay II. Even A Nuclei, Review of Modern Physics, Vol. 23, 1951, pp. 322-327.
4/ R. W. King and J. F. Perkins, Inverse Beta Decay and the Two Component Neutrons, Phys. Rev. Vol. 112, No. 3, pp. 903-960, November 1, 1958.

In the near future it is planned to investigate the effect on our results of incorporating new data for the unknown decays, based upon the procedure suggested by King and Perkins.

INPUT DATA TABULATION

Table II displays all the input data used in carrying out the calculations. The tabulated data, from left to right, is: λ (decay constant), F_{U235} and F_{U238} (initial fission abundance), E_o (beta end point energy), Δ (the fraction going by beta decay), and symbols 0 for allowed and 1 for forbidden spectra. The values of λ, F_{U235}, F_{U238}, and E_o are printed directly from a computer tabulation. The last two digits represent the power of 10 by which the remaining digits, treated as an eight place decimal, are to be multiplied. 51 in this position represents 10^1, 50 represents 10^0, 49 represents 10^{-1}, etc.

Many of the decay schemes contain disintegrations yielding beta, gamma and neutrons. The concern in this report is only with isotopes yielding beta rays. In order to maintain the proper rate of change and growth for the isotopes in these chain decay schemes and avoid unnecessary complication of the program, a simple procedure was used which includes transitions due to all emissions. However, in the computation of $\beta_j(t)$, each member of a chain was assigned a multiplication operator Δ, expressing the percent of the decay that proceeds by beta emission. Where only isomeric gamma decays or neutron decays

occur, Δ is taken as zero. By assigning zero and end-point beta energy to non-beta transitions, we are assured of their not being calculated or tabulated either in the end product of the $\beta_j(t)\rho_j(E)$ calculation or in the machine summation of $\beta_j(t)$, which tests for non-zero end point energy.

TABULATION OF FORMULAE

There is an assigned initial abundance to every possible isotope resulting from fission. As time proceeds each isotope will decay in abundance, characteristic of its decay constant. In addition, the instantaneous amount of each isotope may be increased due to the decay of the members of the chain.

The machine program used to analyze the decay of the fission fragments and compute $\beta_j(t)$ was based upon the following differential equation:

$$\frac{dA_j}{dt} + \lambda_j A_j = A_{j-1} \times \lambda_{j-1} \quad , \qquad (3)$$

where $\beta_j(t) = \lambda_j A_j(t)$

and $A_j(t)$ is the amount of the j^{th} isotope at time t,

where $j = 1 \ldots i_o$. The time differential expresses the rate of change of an isotope (A_j) with decay constant λ_j, in terms of all previous members of a chain and their decay constants.

We assume a solution of the form

$$A_j(t) = \sum_{i=1}^{i=j} \gamma_{ij} \, e^{-\lambda_i t} \tag{4}$$

where the constants γ_{ij} are to be determined from the following recursion relationships:

$$\gamma_{ij} = \left(\frac{\lambda_{j-1}}{\lambda_j - \lambda_i}\right) \gamma_{i,j-1} \quad \text{for } i < j, \text{ and} \tag{5}$$

$$\gamma_{jj} = A_j(0) - \sum_{i=1}^{i=j-1} \gamma_{ij} \, . \tag{6}$$

If a fission fragment mass chain A has a nuclear charge distribution from Z to (Z+ n), the total instantaneous chain activity is

$$\sum_{j=Z}^{Z+n} \beta_j(t) \, . \tag{7}$$

The total activity at $t=t_1$ from all fission chains (A= 72 to 162) used in this study is

$$\sum_{A=72}^{162} \; \sum_{j=Z}^{Z+n} \beta_{j,A}(t_1). \tag{8}$$

THE PROBABILITY FUNCTION $\rho(E)$

$\rho(E)dE$ is the probability that a beta emitted from the j^{th} isotope has an energy between E and E + dE, and is of the form:

$$\rho_j(E) = \frac{E(E^2 - 1)^{\frac{1}{2}} (E_o - E)^2 F(Z + 1,E) \cdot g^2 \xi}{\int_1^{E_o} E(E^2 - 1)^{\frac{1}{2}} (E_o - E)^2 F(Z + 1,E) \cdot g^2 \xi dE} \tag{9}$$

where

E = beta energy in rest mass ($m_o c^2$) units

E_o = beta end point energy in $m_o c^2$ units

$F(Z + 1,E)$ = energy correction term due to the Coulomb distortion of an electron wave amplitude in the Coulomb field of the nucleus[1]

g = Fermi's fundamental coupling constant

$\xi = |C_V|^2 \cdot |<1>|^2 + |C_A|^2 \cdot |<\sigma>|^2$.

A coefficient in the general expression indicating a nuclear matrix element mixture of vector and pseudo-vector coupling.

If it can be assumed that the nuclear matrix element expression in (9) is not a function of the beta or neutrino energy, then (9) reduces to

$$\rho_j(E) \quad \frac{E(E^2 - 1)^{\frac{1}{2}} (E_o - E)^2 F(Z + 1,E)}{\int_1^{E_o} E(E^2 - 1)^{\frac{1}{2}} (E_o - E)^2 F(Z + 1,E) dE} \tag{10}$$

which covers in our study the allowed and once forbidden transitions having allowed shapes. To allow for isotopes having forbidden shapes, $\rho_j(E)$ is modified as follows:

[1] Values for this Coulomb Function were calculated using The Table of the Gamma Function for Complex Arguments, U.S. Bureau of Standards.

$$\rho_j(E) = \frac{E(E^2 - 1)^{\frac{1}{2}} (E_0 - E)^2 F(Z + 1,E) \cdot \{(E^2 - 1) + (E_0 - E)^2\}^{\alpha}}{\int_1^{E_0} E(E^2 - 1)^{\frac{1}{2}} (E_0 - E)^2 F(Z + 1,E) \{(E^2 - 1) + (E_0 - E)^2\}^{\alpha} dE} \tag{11}$$

where α is the degree of forbiddenness. In this study $\alpha = 0$ covers all allowed and once forbidden transitions having allowed shapes. $\alpha = 1$ is used to cover other once or twice forbidden transitions. The energy expression in the brackets is the well-known $p^2 + q^2$ electron and neutrino momentum correction term in m_oc^2 units.

FINAL EXPRESSION

For the member $j = Z$ of chain A in equation (11)

$$\beta_{Z,A}(E,t)dE = \beta_{Z,A}(t) \cdot \Delta \cdot \rho_Z(E)dE \tag{12}$$

$\beta_{ZA}(t)$ is given by equation (5), and Δ is the fraction of the decay that goes by a beta ray.

RESULTS

Some selected results[1] of this analysis, as carried out on the IBM 650, are plotted in Figure 3 for U^{235} and Figure 4 for U^{238}. These two figures give the number of beta rays per fission per energy interval for any specific energy. The short time contribution from highly energetic short-lived isotopes is quite apparent.

1/ The complete calculation for expression (12) for all values of time is on file in IDA/WSEG and is available upon request.

Figures 5(a) through 5(q) and 6(a) through 6(q) present some processed data, the percent of total beta energy per fission per isotope versus time. All fission chains and their constituent members are included for U^{235} and U^{238}.

Figures 7 and 8 present for U^{235} and U^{238} the total beta activity per fission summed over all energy versus time.

Figures 9 and 10 present the total beta energy released per fission per second versus the kinetic energy of the beta rays from fission fragment of U^{235} and U^{238}.

Figures 11 and 12 present the percent of the total beta activity per fission for a few selected times versus the kinetic energy of the beta rays from U^{238} and U^{235} fission fragments.

Figures 13 and 14 present the percent of the total beta energy per interval for a few selected times versus the kinetic energy of the beta rays from U^{235} and U^{238} fission fragments.

Figure 15 compares the result of this study with its assumption of all beta transition to ground state for short half-life unknowns, to those of Cameron1/ and King.2/ While

1/ A. G. W. Cameron, Chalk River Project - 690, 1957.
2/ R. W. King and J. F. Perkins, Inverse Beta Decay and the Two-Component Neutrons, Phys. Rev., Vol. 112, No. 3, pp. 963-966, November 1, 1958.

this study used fission spectrum neutrons in U^{235} fission, the expected difference with thermal neutrons should be very small. It is apparent from Figure 15 that the King and Perkins assumption--of Q_B being shared by beta transitions to non-ground levels as well as gamma from the excited levels to ground--yields a somewhat lower number of high energy betas. The results of this study agree very well with those based upon Cameron's total disintegration energies for the unknown decays.

TABLE I

CALCULATED BETA END POINT ENERGIES [a]

a/ Two primary sources were used in these calculations. Z_A values were taken from Coryell and Sugarman.

Radiochemical Studies: The Fission Product Book 1, McGraw-Hill, page 494, Figure 51.1 and Table 52.10, page 512.

B_A, δ_A, and ϵ_A, from Table II (page 325), Table IV (page 331) and Table I (page 320), respectively, of Annual Review of Nuclear Science, Vol. II, 1953.

The basic equations are:

(1) $Q_B = B_A(Z_A - Z - 0.5) \pm \delta_A$ for (A even).

(2) $Q_B = B_A(Z_A - Z - 0.5) \pm \epsilon_A$ for (A odd).

TABLE I

CALCULATED BETA END POINT ENERGIES

A	Z	Z_A	B_A	A even δ_A	A odd ϵ_A	Use eq. with	$Z_A - Z - .5$	$B_A(Z_A - Z - .5)$	Q^B(MEV)	
72	28	32	2.45	2.82		-	3.5	8.58	5.76	
	29					+	2.5	6.12	8.94	
73	28	32.3	2.42		-.3	-	3.8	9.20		9.50
	29					+	2.8	6.78		6.48
	30					-	1.8	4.36		4.66
74	28	32.7	2.38	2.38		-	4.2	10.00	7.17	
	29					+	3.2	7.62	10.45	
	30					-	2.2	5.24	2.41	
75	29	33	2.36		-.3	+	3.5	8.26		7.96
	30					-	2.5	5.90		6.20
	31					+	1.5	3.54		3.24
76	29	33.4	2.34	2.84		+	3.9	9.13	11.97	
	30					-	2.9	6.79	3.95	
77	29	33.8	2.31		-.3	+	4.3	9.93		9.63
	30					-	3.3	7.62		7.92
	31					+	2.3	5.31		5.01
	32					-	1.3	3.00		3.30
	33				-.1	+	0.3	0.69		.59
78	30	34.2	2.29	2.86		-	3.7	8.47	5.61	
	31					+	2.7	6.18	9.04	
79	30	34.6	2.27		-.3	-	4.1	9.31		9.61
	31					+	3.1	7.04		6.74
	32					-	2.1	4.77		5.07
80	30	35	2.24	2.86		-	4.5	10.08	7.22	
	31					+	3.5	7.84	10.70	
	32					-	2.5	5.60	2.74	
81	31	35.5	2.21		-.3	+	4.0	8.84		8.54
	32				-.3	-	3.0	6.63		6.93
	33				-.1	+	2.0	4.42		4.32
	34				-.1	-	1.0	2.21		2.31
82	31	36	2.18	2.87		+	4.5	9.81	12.68	
	32					-	3.5	7.63	4.76	
	33					+	2.5	5.45	8.32	

TABLE I (Continued)

A	Z	Z_A	B_A	A even δ_A	A odd ϵ_A	Use eq. with	$Z_A - Z - .5$	$B_A(Z_A - Z - .5)$	Q^B(MEV)	
83	32	36.2	2.16		-.3	-	3.8	8.21		8.51
	33				-.1	+	2.8	6.05		5.95
	34				-.1	-	1.8	3.89		3.99
84	32	36.7	2.14	2.88		-	4.2	8.99	6.11	
	33					+	3.2	6.85	9.73	
85	32	37	2.12		-.3	-	4.5	9.54		9.84
	33				-.1	+	3.5	7.42		7.32
	34				-.1	-	2.5	5.30		5.40
	36				-.1	-	0.5	1.06		1.16
86	32	37.5	2.09	2.88		-	5.0	10.45	7.57	
	33					+	4.0	8.36	11.24	
	34					-	3.0	6.27	3.39	
	35					+	2.0	4.18	7.06	
87	33	2.06			-.1	+	4.5	9.27		9.17
	34				-.1	-	3.5	7.21		7.31
	36				-.1	+	1.5	3.09		2.99
88	34	28.5	2.03	2.88		-	4.0	8.12	5.24	
	35					+	3.0	6.09	8.97	
	36					-	2.0	4.06	1.18	
89	34	39	2.01		-.1	-	4.5	9.04		9.14
	35				-.1	+	3.5	7.04		6.94
	36				-.1	-	2.5	5.02		5.12
90	34	39.4	1.99	2.88		-	4.9	9.75	6.87	
91	35	39.9	1.97		-.1	+	4.4	8.67		8.57
	36				-.1	-	3.4	6.70		6.80
	37				-.1	+	2.4	4.73		4.63
	39				+.4	+	0.4	0.79		1.19
92	35	40.3	1.96	2.88		+	4.8	9.41	12.29	
	36+					-	3.8	7.45	4.57	
	37					+	2.8	5.49	8.37	
93	36	40.7	1.94		-.1	-	4.2	8.15		8.25
	37				-.1	+	3.2	6.21		6.11
	38				-.1	-	2.2	4.27		4.37
94	36	41.1	1.92	2.88		-	4.6	8.83	5.95	
	37					+	3.6	6.91	9.79	
	38					-	2.6	4.99	2.11	

TABLE I (Continued)

A	Z	Z_A	B_A	A even δA	A odd ϵA	Use eq. with	Z_A -Z -.5	$B_A(Z_A$ -Z -.5)	Q^B(MEV)
95	36	41.6	1.90		-.1	-	5.1	9.69	9.79
	37				-.1	+	4.1	7.79	7.69
	38				-.1	-	3.1	5.89	5.99
	39				+.4	+	2.1	3.99	4.39
	41				+.4	+	0.1	0.19	.59
96	37	42.1	1.88	2.87		+	4.6	8.65	11.52
	38					-	3.6	6.77	3.90
	39					+	2.6	4.89	7.76
97	37	42.6	1.86		-.1	+	5.1	9.49	9.39
	38				-.1	-	4.1	7.63	7.73
	39				+.4	+	3.1	5.77	5.17
	41				+.4	+	1.1	2.05	2.45
98	38	43	1.85	2.85		-	4.5	8.32	5.47
	39					+	3.5	6.48	9.33
	40					-	2.5	4.62	1.77
	41					+	1.5	2.78	5.63
99	39	43.5	1.83		.4	+	4.0	7.32	7.72
	40				.4	-	3.0	5.49	5.09
	43				.4	+	0.0	0	.4
100	39	44	1.81	2.84		+	4.5	8.14	10.98
	40					-	3.5	6.34	3.50
	41					+	2.5	4.52	7.36
101	39	44.4	1.79		+.4	+	4.9	8.77	9.17
	40				+.4	-	3.9	6.98	6.58
	41				+.4	+	2.9	5.19	5.59
102	40	44.8	1.78	2.82		-	4.3	7.65	4.83
	41					+	3.3	5.87	8.69
	42					-	2.3	4.09	1.27
103	40	45.2	1.76		.4	-	4.7	8.27	7.87
	41				.4	+	3.7	6.51	6.91
	42				.4	-	2.7	4.75	4.35
104	40	45.6	1.75	2.80		-	5.1	8.92	6.12
	41					+	4.1	7.18	9.98
	42					-	3.1	5.42	2.62

TABLE I (Continued)

A	Z	Z_A	B_A	A even δ_A	A odd ϵ_A	Use eq. with	$Z_A - Z - .5$	$B_A(Z_A - Z - .5)$	Q^B(MEV)
105	41	46.0	1.73		.4	+	4.5	7.78	8.18
	42				.4	-	3.5	6.06	5.66
	43				.4	+	2.5	4.32	4.72
	45				.4	+	0.5	.86	1.26
106	41	46.4	1.72	2.77		+	4.9	8.43	11.20
	42					-	3.9	6.71	3.94
						+	2.9	4.99	7.76
107	41	56.8	1.70		.4	+	5.3	9.01	9.41
	42				.4	-	4.3	7.31	6.91
					.4	+	3.3	5.61	6.01
108	42	47.2	1.68	2.74		-	4.7	7.90	5.16
	43					+	3.7	6.22	8.96
	44					-	2.7	4.54	1.80
109	42	47.5	1.67		.4	-	5.0	8.35	7.95
	43				.4	+	4.0	6.68	7.08
	44				.4	-	3.0	5.01	4.61
	45				.2	+	2.0	3.34	3.54
110	42	47.8	1.66	2.72		-	5.3	8.80	6.08
	43					+	4.3	7.14	9.86
	44					-	3.3	5.48	2.76
	45					+	2.3	3.82	6.54
111	43	48.1	1.65		.4	+	4.6	7.59	7.99
	44				.4	-	3.6	5.94	5.54
	45				.2	+	2.6	4.29	4.49
112	43	48.4	1.64	2.69		+	4.9	8.04	10.73
	44					-	3.9	6.40	3.71
	45					+	2.9	4.76	7.45
113	44	48.7	1.62		.4	-	4.2	6.80	6.40
	45				.2	+	3.2	5.18	5.38
	46				0	-	2.2	3.56	3.56
114	44	49.0	1.61	2.66		-	4.5	7.24	4.58
	45					+	3.5	5.64	8.30
	46					-	2.5	4.02	1.36
	47					+	1.5	2.41	5.07

TABLE I (Continued)

A	Z	Z_A	B_A	A even δA	A odd ϵA	Use eq. with	Z_A - Z -.5	$B_A(Z_A$ -Z -.5)	Q^B(MEV)
115	44				0	-	4.8	7.68	7.68
	45	49.3	1.60		.2	+	3.8	6.08	6.28
	46				0	-	2.8	4.48	4.48
	48				0	-	0.8	1.28	1.28
	49				.5	+	-0.2	-.32	.18
116	45	49.6	1.59	2.62		+	4.1	6.52	9.14
	46					-	3.1	4.93	2.31
117	45	49.9	1.58		.2	+	4.4	6.95	7.15
	46				0	-	3.4	5.37	5.37
	47				0	+	2.4	3.79	3.79
	48				0	-	1.4	2.21	2.21
	49				.5	+	0.4	.63	1.13
118	45	50.2	1.57	2.58		+	4.7	7.38	9.96
	46					-	3.7	5.81	3.23
	47					+	2.7	4.24	6.82
	48					-	1.7	2.67	.09
119	45	50.5	1.56		.2	+	5.0	7.80	8.00
	46				0	-	4.0	6.24	6.24
	47				0	+	3.0	4.68	4.68
	48				0	-	2.0	3.12	3.12
	49				.5	+	1.0	1.56	2.06
120	46	50.8	1.54	2.55		-	4.3	6.62	4.07
	47					+	3.3	5.08	7.63
	48					-	2.3	3.54	.99
	49					+	1.3	2.00	4.55
121	46	51.1	1.53		0	-	4.6	7.04	7.04
	47				0	+	3.6	5.51	5.51
	48				0	-	2.6	3.98	3.98
	49				.5	+	1.6	2.45	2.95
	50				0	-	0.6	.92	.92
122	46	51.4	1.52	2.51		-	4.9	7.45	4.94
	47					+	3.9	5.93	8.44
	48					-	2.9	4.41	1.90
	49					+	1.9	2.89	5.40
123	47	51.7	1.51		0	+	4.2	6.34	6.34
	48				0	-	3.2	4.83	4.83
	49				.5	+	2.2	3.32	3.82

TABLE I (Continued)

A	Z	Z_A	B_A	A even δA	A odd ϵA	Use eq. with	Z_A -Z -.5	$B_A(Z_A$ -Z -.5)	Q^B(MEV)
124	47	52.0	1.51	2.47		+	4.5	6.80	9.27
	48					-	3.5	5.28	2.81
	49					+	2.5	3.78	6.25
125	47	52.3	1.50		0	+	4.8	7.20	7.20
	48				0	-	3.8	5.70	5.70
					.5	+	2.8	4.20	4.70
126	48	52.6	1.49	2.40		-	4.1	6.11	3.71
	49					+	3.1	4.62	7.02
	50					-	2.1	3.13	.73
127	48	52.9	1.48		0	-	4.4	6.51	6.51
	49				.5	+	3.4	5.03	5.53
	50				0	-	2.4	3.55	3.55
	52				0	-	0.4	.59	.59
128	48	53.2	1.47	2.35		-	4.7	6.91	4.56
	49					+	3.7	5.44	7.79
	50					-	2.7	3.97	1.62
129	48	53.5	1.46		.5	+	4.0	5.84	6.34
	50				0	-	3.0	4.38	4.38
	51				-.4	+	2.0	2.92	2.52
	52				0	-	1.0	1.46	1.46
130	49	53.9	1.46	2.29		+	4.4	6.42	8.71
	50					-	3.4	4.96	2.67
	51					+	2.4	3.50	5.79
131	49				.5	+	4.7	6.81	7.31
	50	54.2	1.45		0	-	3.7	5.36	5.36
	51				-.4	+	2.7	3.92	3.52
	52				0	-	1.7	2.46	2.46
	53				0	+	0.7	1.01	1.01
	54				0	-	-0.3	-.44	-.44
132	50	54.5	1.44	2.24		-	4.0	5.76	3.52
	51					+	3.0	4.32	6.56
133	50	54.9	1.43		0	-	4.4	6.29	6.29
	51				-.4	+	3.4	4.86	4.46
	52				0	-	2.4	3.43	3.43

TABLE I (Continued)

A	Z	Z_A	B_A	A even δ_A	A odd ε_A	Use Eq. with	Z_A - Z -.5	$B_A(Z_A$ - Z -.5)	Q^B(MEV)	
134	51	55.3	1.42	2.19		+	3.8	5.40	7.59	
	52					-	2.8	3.98	1.79	
135	51	55.7	1.41		-.4	+	4.2	5.92		5.52
	52				0	-	3.2	4.51		4.51
136	51	56.1	1.40	2.14		+	4.6	6.44	8.58	
	52					-	3.6	5.04	2.90	
137	52	56.5	1.39		0	-	4.0	5.56		5.56
138	52					-	4.5	6.165	4.07	
	53	57.0	1.37	2.09		+	3.5	4.80	6.89	
139	53	57.5	1.36		0	+	4.0	5.44		5.44
	54				0	-	3.0	4.08		4.08
	55				0	+	2.0	2.72		
140	53					+	4.5	6.075	8.13	
	54	58.0	1.35	2.05		-	3.5	4.72	2.67	
	55					+	2.5	3.38	5.43	
141	54	58.5	1.34		0	-	4.0	5.36		5.36
	55				0	+	3.0	4.02		4.02
142	54	59.0	1.33	2.0		-	4.5	5.98	3.98	
	55					+	3.5	4.65	6.65	
	56					-	2.5	3.32	1.32	
	57					+	1.5	2.00	4.00	
143	55	59.5	1.32		0	+	4.0	5.28		5.28
	56				0	-	3.0	3.96		3.96
	57				.35	+	2.0	2.64		2.99
144	55	59.9	1.31	1.97		+	4.4	5.76	7.73	
	56					-	3.4	4.45	2.48	
	57					+	2.4	3.14	5.11	
145	55	60.4	1.30		0	+	4.9	6.37		6.37
	56				0	-	3.9	5.07		5.07
	57				.35	+	2.9	3.77		4.12
146	56	60.9	1.28	1.93		-	4.4	5.63	3.70	
	57					+	3.4	4.35	6.28	

TABLE I (Continued)

A	Z	Z_A	B_A	A even δ_A	A odd ϵ_A	Use eq. with	$Z_A - Z - .5$	$B_A(Z_A - Z - .5)$	Q^B(MEV)
147	56	61.4	1.27		0	-	4.9	6.22	6.22
	57				.35	+	3.9	4.95	5.30
	58				0	-	2.9	3.68	3.68
	59				.35	+	1.9	2.41	2.76
	60				0	-	0.9	1.14	1.14
148	57	61.9	1.26	1.89		+	4.4	5.54	7.43
	58					-	3.4	4.28	2.39
	59					+	2.4	3.02	4.91
149	57	62.3	1.25		.35	+	4.8	6.00	6.35
	58				0	-	3.8	4.75	4.75
	59				.35	+	2.8	3.50	3.85
150	58	62.6	1.25	1.86		-	4.1	5.12	3.26
	59					+	3.1	3.88	5.74
151	58	62.9	1.24		0	-	4.4	5.45	5.45
	59				.35	+	3.4	4.22	4.57
152	58	63.2	1.24	1.84		-	4.7	5.83	3.99
	59					+	3.7	4.59	6.43
	60					-	2.7	3.35	1.51
	61					+	1.7	2.11	3.95
153	59	63.5	1.23		.35	+	4.0	4.92	5.27
	60				0	-	3.0	3.69	3.69
	61				.35	+	2.0	2.46	2.81
154	59	63.9	1.22	1.80		+	4.4	5.37	7.17
	60					-	3.4	4.15	2.35
	61					+	2.4	2.93	4.73
155	59	64.3	1.21		.35	+	4.8	5.81	6.16
	60				0	-	3.8	4.60	4.60
	61				.35	+	2.8	3.39	3.74
156	60	64.6	1.21	1.77		-	4.1	4.96	3.19
	61					+	3.1	3.75	5.52
157	60	64.8	1.20		0	-	4.3	5.16	5.16
	61				.35	+	3.3	3.96	4.31
	62				0	-	2.3	2.76	2.76

TABLE I (Continued)

A	Z	Z_A	B_A	A even A	A odd A	Use Eq. with	Z_A - Z -.5	$B_A(Z_A$ - Z -.5)	Q^B(MEV)
158	60	65.1	1.20	1.74		-	4.6	5.52	3.78
	61					+	3.6	4.32	6.06
	62					-	2.6	3.12	1.38
159	61	65.3	1.20		.35	+	3.8	4.56	4.91
	62				0	-	2.8	3.36	3.36
160	65.5		1.19	1.72		+	4.0	4.76	6.48
	62					-	3.0	3.57	1.85
	63					+	2.0	2.38	4.10
161	62	65.7	1.19		0	-	3.2	3.81	3.81
	63				.2	+	2.2	2.62	2.82
162	62	65.9	1.19	1.70		-	3.4	4.05	2.35
	63					+	2.4	2.86	4.56
	64					-	1.4	1.67	-.03

A	Z	LAMBD	FU238	FU235	E0	Δ	Forbidden	A	Z	LAMBD	FU238	FU235	
72	28	1980000050	2600000046	5220000043	1180000052	1000000051	0	91	36	7070000049	1440000049	2028000049	7200
72	29	6930000049	2900000046	6960000043	1780000052	1000000051	0	91	37-	6930000048	1700000048	3720000048	9200
72	30	3930000045	1000000046	3600000043	6000000050	9500000050	0	91	37-	6930000048	2550000048	5580000048	9200
					3200000051	5000000049	0	91	37	8250000047	3400000048	7360000048	6000
72	31	1350000046	1400000044	2200000042	1280000051	4200000050	0	91	38	1990000046	6120000047	3060000048	5340
					1920000051	3100000050	0						4060
					3020000051	1000000050	0						2720
					5060000051	9000000049	0						2180
					6340000051	8000000049	0						1240
73	28	3460000050	2500000046	2020000044	1900000052	1000000051	0	91	39	1380000044	5000000044		3080
73	29	9900000049	4600000046	4320000044	1290000052	1000000051	0	92	35	4620000050	4620000048	3900000048	2500
73	30	1540000049	2600000046	3180000044	9300000051	1000000051	0	92	36	2310000050	1550000049	1990000049	9140
73	31	3850000044	2600000045	4800000043	2800000051	1000000051	0	92	37	8660000048	1370000049	2430000049	1674
74	28	4620000050	2260000046	2200000044	1430000052	1000000051	0	92	38	7400000046	3140000048	9600000048	1100
74	29	1730000050	7800000046	9100000044	2090000052	1000000051	0						3000
74	30	2570000048	7200000046	1020000045	4800000051	1000000051	0	92	39	8350000046	4100000046	3000000047	7200
74	31	1480000048	1800000046	3380000044	5300000051	3330000050	0						5400
					4000000051	3330000050	0						2600
					2200000051	3330000050	0	93	36	3460000050	1500000049	1210000049	16500
75	29	2770000050	1100000047	2820000045	1590000052	1000000051	0	93	37	9900000049	1800000049	2590000049	12200
75	30	7290000049	1600000047	4360000045	1240000052	1000000051	0	93	38	1410000048	6800000048	1910000049	87400
75	31	9900000048	7000000046	2590000045	6500000051	1000000051	0	93	39	1850000046	1400000047	2900000048	57600
75	32	1410000047	2800000045	2300000044	2280000051	8500000050	0						52000
					1228000051	1500000050	0						38800
76	29	3460000050	1100000047	3890000045	2390000052	1000000051	0						29600
76	30	8660000049	2700000047	9660000045	7900000051	1000000051	0						14800
76	31	2310000049	1800000047	7890000045	1460000052	1000000051	0	94	36	4950000050	9700000048	4200000048	11900
77	29	4620000050	7800000046	5300000045	1930000052	1000000051	0	94	37	2310000050	1980000049	2130000049	19580
77	30	1980000050	3620000047	2190000046	1580000052	1000000051	0	94	38	8880000048	1280000049	2600000049	42200
77	31	4620000049	4120000047	2450000046	1000000052	1000000051	0	94	39	7000000047	1720000048	1020000049	10800
77	32-	1170000049	7620000046	4000000045	5460000051	1000000051	0	95	36	6930000050	4110000048	4570000048	19600
77	32	1600000046	5080000046	4100000045	4390000051	4200000050	1	95	37	3460000050	1790000049	1500000049	15300
					2760000051	3500000050	0	95	38	1650000049	1930000049	2740000049	12000
					1420000051	2300000050	0	95	39	1100000048	5650000048	1830000049	86800
77	33	4940000045	1100000045	2000000044	1360000051	9800000050	0	95	40	1230000044	3500000046	2200000048	72000
78	30	2770000050	4720000047	4230000046	1120000052	1000000051	0						79200
78	31	8660000049	7360000047	6540000046	1808000052	1000000051	0						17800
78	32	1340000047	3680000047	3890000046	1800000051	1000000051	0	95	41-	2140000045			
78	33	1270000047	2400000046	3500000045	8200000051	7000000050	0	95	41	2290000044			31600
					2800000051	3000000050	0	96	37	6930000050	1570000049	5700000048	22900
79	30	4620000050	3500000047	6400000046	1922000052	1000000051	0	96	38	2770000050	2350000049	2340000049	78000
79	31	1540000050	1030000048	1600000047	1348000052	1000000051	0	96	39	6930000049	1120000049	2620000049	15500
79	32	2770000049	8400000047	1300000047	1014000052	1000000051	0	97	37	6930000050	8280000048	9200000048	18700
79	33	1280000048	1800000047	7600000046	4600000051	1000000051	0	97	38	4620000050	2380000049	1800000049	15400
80	30	4620000050	2080000047	4900000046	1444000052	1000000051	0	97	39	1390000050	1840000049	2790000049	12340
80	31	2310000050	1150000048	2470000047	2140000052	1000000051	0	97	40	1130000046	3510000048	1650000049	38200
80	32	2770000049	1490000048	3020000047	5480000051	1000000051	0						92000
80	33	1920000049	5440000047	1190000047	1100000052	1000000051	0	97	41-	1160000049	7500000045	7000000047	
81	31	3460000050	1070000048	4230000047	1708000052	1000000051	0	97	41	1560000047		7000000047	24000
81	32	9900000049	2160000048	6540000047	1386000052	1000000051	0	98	38	6930000050	8150000048	6800000048	10940
81	33	1390000049	1320000048	3890000047	8500000051	1000000051	0	98	39	2770000050	2430000049	2420000049	18660
81	34-	2030000047	9000000045	1800000046		1000000051	0	98	40	4620000049	1980000049	2420000049	35000
81	34	6420000047	1410000047	1700000046	2760000051	1000000051	0	98	41	4440000047	4240000048	6800000048	11200
82	31	4620000050	1200000048	3840000047	2536000052	1000000051	0	99	39	4620000050	2170000049	1690000049	15400

A	Z	LAMBD	FU238	FU235	E0	Δ	Forbidden	A	Z	LAMBD	FU238	FU235	
82	32	1390000050	2790000048	1145000048	9500000051	1000000051	0	99	40	2310000049	2540000049	2620000049	10200
82	33	3850000049	1920000048	1020000048	1662000052	1000000051	0	99	41	3040000048	9700000048	1550000049	64000
83	32	3460000050	3220000048	1860000048	1700000052	1000000051	0	99	42	2920000045	2000000047	1400000048	23600
83	33	9900000049	3560000048	2200000048	1190000052	1000000051	0						16000
83	34-	7700000047	5720000047	5000000047	3000000051	1000000051	0						82000
83	34	9900000048	7280000047	5000000047	6800000051	1000000051	0	100	39	4620000050	1290000049	7800000048	22000
83	35	1400000047	1800000046	4000000046	1880000051	8000000050	0	100	40	1980000050	2600000049	2330000049	70000
84	32	4620000050	3240000048	1620000048	1222000052	1000000051	0	100	41	2570000049	1580000049	2080000049	14700
84	33	2770000050	4830000048	3460000048	1946000052	1000000051	0	101	39	6930000050	6180000048	6867000048	18300
84	34	3500000048	2310000048	2540000048	2600000051	1000000051	0	101	40	2770000050	2180000049	1790000049	13200
84	35	3610000047	1150000047	3800000047	9360000051	4000000050	0	101	41	6300000049	2010000049	2120000049	11200
					7120000051	9000000049	0	101	42	7910000047	4900000048	9600000048	44000
					5060000051	1600000050	0						24000
					3440000051	3500000050	0	101	43	8250000047	2100000046	3000000047	26400
85	32	6930000050	2010000048	1440000048	1968000052	1000000051	0						21000
85	33	1610000051	5720000048	5080000048	1464000052	1000000051	0	102	40	3460000050	1770000049	8500000048	96600
85	34	1730000049	4420000048	5080000048	1080000052	1000000051	0	102	41	9900000049	2250000049	1810000049	17380
85	35	3850000048	8450000047	1440000048	5000000051	1000000051	0	102	42	1000000048	9500000048	1330000049	25400
85	36-	4380000046	1160000045		1660000051	7700000050	1	102	43	1390000050	2450000047	2000000048	88000
85	36	2130000042	3000000044		1390000051	9900000050	1	103	40	4620000050	8580000048	3700000048	157400
					3000000050	6000000048	0	103	41	1730000050	2030000049	1330000049	138200
86	32	6930000050	1420000048	1578000048	1514000052	1000000051	0	103	42	2770000049	1400000049	1330000049	87000
86	33	3460000050	5440000048	5640000048	2248000052	1000000051	0	103	43	9620000048	2110000048	3700000048	
86	34	4080000049	6880000048	8720000048	6780000051	1000000051	0	103	44	2020000044	3700000045		440000
86	35	2170000049	2240000048	5180000048	1412000052	1000000051	0						137000
87	33	4620000050	1700000048	3840000048	1834000052	1000000051	0	103	45	2030000047			
87	34	4080000049	7500000048	1150000049	1442000052	1000000051	0	104	40	4620000050	3670000048	4078000048	122400
87	35	1250000049	7704000048	1020400049	5200000051	7000000050	0	104	41	2310000050	1520000049	6800000048	199600
					1600000052	2800000050	0	104	42	3850000049	1640000049	9100000048	524000
87	36	1480000047	2090000048	2500000048	7600000051	7000000050	0	104	43	6420000047	4800000048	4700000048	600000
					6600000051	5000000049	0	105	41	3460000050	9670000048	2366000048	163600
					2600000051	2500000050	0	105	42	1160000050	1600000049	5880000048	113200
88	34	2770000050	6820000048	1140000049	1048000052	1000000051	0	105	43	1160000048	7820000048	4802000048	944000
88	35	4470000049	1010000049	1520000049	1794000052	9900000050	0	105	44	4280000046	5100000047	9520000047	230000
88	36	6950000046	4840000048	7900000048	5600000051	2000000050	1	105	45-	1340000049			
					1800000051	1200000050	0	105	45	2310000050			114000
					1040000051	6800000050	0						500000
88	37	6490000047	2420000047	5000000047	1026000052	6600000050	0	106	41	4620000050	4170000048	6160000047	224000
					6580000051	1900000050	0	106	42	1730000050	1190000049	2560000048	788000
					4000000051	1500000050	0	106	43	7700000049	9160000048	2870000048	155200
89	34	3460000050	4850000048	7800000048	1828000052	1000000051	0	106	44	2200000043	1760000048	9520000047	780000
89	35	1540000050	1140000049	1940000049	1388000052	1000000051	0	106	45	2310000049	3800000045		700000
89	36	3630000048	8320000048	1580000049	8000000051	1000000051	0						460000
89	37	7500000047	1430000048	3100000048	7840000051	7000000049	1	107	41	6930000050	1210000048		188200
					5600000051	5000000049	0	107	42	2770000050	7140000048	9130000047	138200
					1800000051	8800000050	0	107	43	1920000047	9240000048	[illegible]	[illegible]
89	38	1590000044	2900000045		2950000051	1000000051	1	107	44	2890000048	33600		
90	34	6930000050	2350000048		1374000052	1000000051	0	107	45	4810000047	46000		
90	35	4950000050	1050000049	1870000049		1000000051	0	107	46	5420000047			
90	36	2100000049	1290000049	2200000049	6400000051	1000000051	0	108	42	3460000050	36700		
90	37	4220000048	4200000048	1000000049	1140000052	1000000051	0	108	43	1980000050	70500		
90	38	7930000041	4800000046	4000000047	1100000051	1000000051	1	108	44	2890000048	39000		
90	39	3000000045			4520000051	9900000050	1	108	45	3850000049	37500		
91	35	3460000050	7930000048	8280000048	1714000052	1000000051	0	109	42	4620000050	12900		

Δ	Forbidden	A	Z	LAMBD	Fu238	Fu235	EO	Δ
1000000051	0	91	36	7070000049	1440000049	2025000049	7200000051	1000000051
1000030051	0	91	37-	6930000048	1700000048	3720000048	9200000051	1000000051
9500000050	0	91	37-	6930000048	2550000048	5580000048	9200000051	1000000051
5000000049	0	91	37	8250000047	3400000048	7360000048	6000000051	1000000051
4200000050	0	91	38	1990000046	6120000047	3060000048	5340000051	2600000050
3100000050	0						4060000051	4000000049
1000000050	0						2720000051	2900000050
9000000049	0						2180000051	3300000050
8000000049	0						1840000051	7000000049
1000000051	0	91	39	1380000044	5000000044		3080000051	1000000051
1000000051	0	92	35	4620000050	4620000048	3900000048	2800000052	1000000051
1000000051	0	92	36	2310000050	1550000049	1990000049	9140000051	1000000051
1000000051	0	92	37	8660000048	1370000049	2430000049	1674000052	1000000051
1000000051	0	92	38	7400000046	3140000048	9600000048	1100000051	9000000050
1000000051	0						3000000051	1000000050
1000000051	0	92	39	5350000046	4100000046	3000000047	7200000051	3300000050
3330000050	0						5400000051	3300000050
3330000050	0						2600000051	3300000050
3330000050	0	93	36	3460000050	1500000049	1210000049	1650000052	1000000051
1000000051	0	93	37	9900000049	1800000049	2590000049	1220000052	1000000051
1000000051	0	93	38	1410000048	6800000048	1910000049	8740000051	1000000051
1000000051	0	93	39	1050000046	1400000047	2900000048	5760000051	8500000050
8500000050	0						5200000051	5500000049
1500000050	0						3880000051	4700000049
1000000051	0						2960000051	1800000049
1000000051	0						1480000051	3100000049
1030000051	0	94	36	4950000050	9700000048	4200000048	1190000052	1000000051
1000000051	0	94	37	2310000050	1980000049	2130000049	1950000052	1000000051
1000000051	0	94	38	8880000048	1280000049	2600000049	4220000051	1000000051
1000000051	0	94	39	7000000047	1720000048	1020000049	1080000052	1000000051
1000000051	0	95	36	6930000050	4110000048	4570000048	1960000052	1000000051
4200000050	1	95	37	3460000050	1790000049	1500000049	1530000052	1000000051
3500000050	0	95	38	1650000049	1930000049	2740000049	1200000052	1000000051
2300000050	0	95	39	1100000048	5680000048	1830000049	8680000051	1000000051
9800000050	0	95	40	1230000044	3500000046	2200000048	7200000050	4300000050
1000000051	0						7920000050	5500000050
1000000051	0						1780000051	2000000049
1000000051	0	95	41-	2140000045				1000000051
7000000050	0	95	41	2290000044			3160000050	1000000051
3000000050	0	96	37	6930000050	1570000049	5700000048	2290000052	1000000051
1000000051	0	96	38	2770000050	2350000049	2340000049	7800000051	1000000051
1000000051	0	96	39	6930000049	1120000049	2620000049	1550000052	1000000051
1000000051	0	97	37	6930000050	8260000048	9200000048	1870000052	1000000051
1000000051	0	97	38	4620000050	2380000049	1800000049	1540000052	1000000051
1000000051	0	97	39	1390000050	1840000049	2790000049	1234000052	1000000051
1000000051	0	97	40	1130000046	3510000048	1650000049	3820000051	9900000050
1000000051	0						9200000050	1000000049
1000000051	0	97	41-	1160000049	7500000048	7000000047		1000000051
1000000051	0	97	41	1560000047		7000000047	2400000051	1000000051
1000000051	0	98	38	6930000050	8150000048	6800000048	1094000052	1000000051
1000000051	0	98	39	2770000050	2430000049	2420000049	1864000052	1000000051
1000000051	0	98	40	4620000049	1980000049	2420000049	3500000051	1000000051
1000000051	0	98	41	4440000047	4240000048	6800000048	1120000052	1000000051
1000000051	0	99	39	4620000050	2170000049	1690000049	1540000052	1000000051

Forbidden	A	Z	LAMBD	Fu238	Fu235	EO	Δ
0	109	43	2770000050	4520000048	2040000047	1416000052	1000000
0	109	44	4330000049	4180000048	2300000047	9220000051	1000000
0	109	45	2890000047	1000000048	7600000046	7080000051	1000000
1	109	46	1380000046	4400000045		2000000051	9900000
1	110	42	6930000050	4600000047	1300000047	1215000052	1000000
0	110	43	3460000050	2920000048	1740000047	1972000052	1000000
0	110	44	6930000049	4230000048	1360000046	5520000051	1000000
0	110	45	3460000049	1790000048	9000000046	1308000052	1000000
0	111	43	4620000050	1610000048	5400000046	1600000052	1000000
1	111	44	1730000050	3780000048	1300000047	1108000052	1000000
0	111	45	5780000049	2610000048	1098000047	8980000051	1000000
0	111	46	4440000047	3950000047	2180000046	4300000051	1000000
0	111	47	1060000045	6000000044		2080000051	9100000
1						1600000051	1000000
0						1400000051	8000000
1	112	43	4620000050	6960000047	2500000046	2146000052	1000000
0	112	44	2310000050	2960000048	1022000047	7420000051	1000000
0	112	45	9900000049	3200000048	1146000047	1490000052	1000000
0	112	46	9170000045	9370000047	3780000046	5000000050	1000000
0	112	47	6020000046	6200000045	6000000044	8200000051	2500000
0						7000000051	4000000
1						5400000051	2000000
0						2000000051	1500000
0	113	44	3460000050	2140000048	9120000046	1280000052	1000000
0	113	45	1730000050	3440000048	1218000047	1076000052	1000000
0	113	46	8250000048	1700000048	6300000046	7020000051	1000000
0	113	47	3630000046	1110000047	4000000045	4200000051	1000000
0	114	44	4620000050	1110000048	5260000046	9060000051	1000000
0	114	45	2310000050	3170000048	1124000047	1660000052	1000000
1	114	46	4810000048	2450000048	8260000046	2720000051	1000000
0	114	47	5780000048	4680000047	1240000046	1014000052	1000000
0	115	44	6930000050	4840000047	2420000046	1536000052	1000000
0	115	45	2770000050	2780000048	8580000046	1256000052	1000000
1	115	46	1540000049	3080000048	8580000046	8960000051	1000000
1	115	47	5470000047	1120000050	2420000046	5800000051	1000000
0	115	48-	1860000044	1400000045		3220000051	9800000
0						1400000051	2000000
0	115	48	3630000045			3220000051	5800000
1						1160000051	4200000
0	115	49-	4280000046			1660000051	5000000
0	116	45	3460000050	1720000048	7000000046	1826000052	1000000
0	116	46	6930000049	3210000048	9500000046	4620000051	1000000
0	116	47	4620000048	1790000048	4300000046	1000000052	1000000
0	117	45	4620000050	2410000048	4780000046	1430000052	1000000
0	117	46	1390000050	3060000048	8700000046	1074000052	1000000
0	117	47	1050000049	1290000048	5800000046	7580000051	1000000
0	117	48	7080000046	3300000046	7200000045		1000000
0	117	49-	1010000047			3540000051	5500000
0						3240000051	2300000
0	117	49	1750000047			1480000051	1000000
0	118	45	4620000050	1970000048	3020000046	1992000052	1000000
0	118	46	1540000050	3160000048	9000000046	6460000051	1000000
0	118	47	2770000049	1560000048	8040000046	1364000052	1000000
0	118	48	2310000047	1020000047	1960000046	1800000050	1000000

Δ	Forbidden	A	Z	LAMBD	Fu238	Fu235	EO	Δ
1000000051	0	99	40	2310000049	2540000049	2620000049	1020000052	1000000051
1000000051	0	79	41	3040000048	9700000048	1580000049	6400000051	1000000051
1000000051	0	99	42	2920000045	2000000047	1400000048	2360000051	8300000050
1000000051	0						1600000051	3000000049
1000000051	0						8200000050	1400000050
1000000051	0	100	39	4620000050	1290000049	7800000048	2200000052	1000000051
8000000050	0	100	40	1980000050	2600000049	2330000049	7000000051	1000000051
1000000051	0	100	41	2570000049	1580000049	2080000049	1470000052	1000000051
1000000051	0	101	39	6930000050	6180000048	6847000048	1830000052	1000000051
1000000051	0	101	40	2770000050	2180000049	1790000049	1320000052	1000000051
4000000050	0	101	41	6300000049	2010000049	2120000049	1120030052	1000000051
9000000049	0	101	42	7910000047	4900000048	5600000048	4400000051	7000000050
1600000050	0						2400000051	3000000050
3500000050	0	101	43	8250000047	2100000046	3000000047	2640000051	9700000050
1000000051	0						2100000051	3000000049
1000000051	0	102	40	3460000050	1770000049	8500000048	9640000051	1000000051
1000000051	0	102	41	9900000049	2250000049	1810000049	1738000052	1000000051
1000000051	0	102	42	1000000048	9500000048	1330000049	2540000051	1000000051
7700000050	1	102	43	1390000050	2450000047	2000000048	8800000051	1000000051
9900000050	1	103	40	4620000050	8880000048	3700000048	1574000052	1000000051
6000000048	0	103	41	1730000050	2030000049	1330000049	1382000052	1000000051
1000000051	0	103	42	2770000049	1400000049	1330000049	8700000051	1000000051
1000000051	0	103	43	9620000048	2110000048	3700000048		1000000051
1000000051	0	103	44	2020000044	3700000045		4400000050	9400000050
1000000051	0						1370000051	6000000049
1000000051	0	103	45	2030000047				1000000051
1000000051	0	104	40	4620000050	3670000048	4078000048	1224000052	1000000051
7000000050	0	104	41	2310000050	1520000049	6800000048	1994000052	1000000051
2800000050	0	104	42	3850000049	1640000049	9100000048	5240000051	1000000051
7000000050	0	104	43	6420000047	4800000048	4700000048	6000000051	1000000051
5000000049	0	105	41	3460000050	9670000048	2366000048	1636000052	1000000051
2500000050	0	105	42	1160000050	1600000049	5880000048	1132000052	1000000051
1000000051	0	105	43	1160000048	7820000048	4802000048	9440000051	1000000051
9900000050	0	105	44	4280000046	5100000047	9520000047	2300000051	1000000051
2000000050	1	105	45-	1540000049				1000000051
1200000050	0	105	45	2310000050			1140000051	9500000050
6800000050	0						5000000050	5000000049
6600000050	0	106	41	4620000050	4170000048	6160000047	2240000052	1000000051
1900000050	0	106	42	1730000050	1190000049	2560000048	7880000051	1000000051
1500000050	0	106	43	7700000049	9160000048	2870000048	1552000052	1000000051
1000000051	0	106	44	2200000043	1760000048	9520000047	7800000049	1000000051
1000000051	0	106	45	2310000049	3800000045		7000000051	8200000050
1000000051	0						4600000051	1800000050
7000000049	1	107	41	6930000050	1210000048		1882000052	1000000051
5000000049	C	107	42	2770000050	7140000048	9130000047	1382000052	1000000051
8800000050	0	107	43	1920000047	9240000048	1220000048	1202000052	1000000051
1000000051	1	107	44	2890000048	3360000048	6300000047	8000000051	1000000051
1000000051	0	107	45	4810000047	4600000046	3780000048	2300000051	9980000050
1000000051	0	107	46	5420000047				1000000051
1000000051	0	108	42	3460000050	3670000048	1570000047	1032000052	1000000051
1000000051	0	108	43	1980000050	7050000048	3880000047	1792000052	1000000051
1000000051	1	108	44	2890000048	3900000048	3160000047	3600000051	1000000051
9900000050	1	108	45	3850000049	3750000047	6300000046	9000000051	1000000051
1000000051	0	109	42	4620000050	1290000048	5000000046	1590000052	1000000051

Forbidden	A	Z	LAMBD	Fu238	Fu235	EO	Δ
0	118	49	1260000050			8800000051	1000000
0	119	45	4620000050	1060000048	1840000046	1600000052	1000000
1	119	46	2310000050	3040000048	8240000046	1248000052	1000000
0	119	47	4080000049	2380000048	1010000047	9360000051	1000000
0	119	48-	3980000048	2240000047	1120000046	6240000051	1000000
0	119	48	1160000048	2240000047	1120000046	6240000051	1000000
0	119	49	6600000047	9700000044	1000000045	5400000051	1000000
0	120	46	3460000050	2780000048	6760000046	8140000051	1000000
0	120	47	1160000050	3080000048	1044000047	1524000052	1000000
0	120	48	9620000047	1120000048	6220000046	1980000051	1000000
0	120	49	1260000049	1500000046	5600000045	2000000051	1000000
1	121	46	4620000050	1800000048	4400000046	1408000052	1000000
0	121	47	1730000050	3350000048	1092000047	1102000052	1000000
0	121	48	2770000049	1870000048	8920000046	7960000051	1000000
0	121	49	9240000048	1800000047	1780000046	5900000051	1000000
0	121	50	7130000045			7660000050	1000000
0	122	46	4620000050	8800000047	2680000046	9880000051	1000000
1	122	47	2310000050	3030000048	1096000047	1688000052	1000300
0	122	48	1730000049	2810000048	1228000047	3800000051	1000000
0	122	49	1540000049	6800000047	4060000046	1080000052	1000000
0	123	47	2770000050	2770000048	7756000046	1268000052	1000000
0	123	48	7700000049	3510000048	1036000047	9660000051	1000000
0	123	49	2310000049	1480000048	5362000046	7640000051	1000000
1	123	50	5900000043	3800000046	3360000045	2840000051	1000000
0	124	47	3460000050	1580000048	5656000046	1854000052	1000000
0	124	48	6930000049	3690000048	1210000047	5620000051	1000000
0	124	49	3460000049	2540000048	8904000046	1250000052	1000000
0	125	47	3460000050	7200000047	3122000046	1440000052	1000000
0	125	48	1390000050	3340000048	1278000047	1140000052	1000000
0	125	49	4620000049	3610000048	1432000047	9400000051	1000000
0	125	50	8530000044	1060000048	4732000046	4740000051	9500000
0						8000000050	5000000
0	125	51	1100000043	7000000046	7000000044	1220000051	1400000
1						6000000050	4500000
0						8800000050	1200000
0						2600000050	2900000
0	126	48	2310000050	3050000048	3684000047	7420000051	1000000
0	126	49	9900000049	4880000048	4872000047	1404000052	1000000
0	126	50	2310000047	2410000048	2520000047	1460000051	1000000
0	126	51	2140000046	1580000047	1540000046	2000000051	1000000
0	127	48	4620000050	2160000048	4540000047	1302000052	1000000
0	127	49	2310000050	6160000048	9690000047	[illegible]	[illegible]
0	127	50	9170000046	4760000048	7130000[illegible]	[illegible]	[illegible]
0	127	51	2190000045	9100000047	1080000[illegible]	[illegible]	[illegible]
0						[illegible]	[illegible]
0						[illegible]	[illegible]
1	127	52-	7640000043	3900000044		[illegible]	[illegible]
0	127	52	2050000046	1600000045		[illegible]	[illegible]
0	128	48	6930000050	1270000048	644000[illegible]	[illegible]	[illegible]
0	128	49	3460000050	7480000048	229600[illegible]	[illegible]	[illegible]
0	128	50	2030000047	9680000048	229600[illegible]	[illegible]	[illegible]
0	128	51	1120000048	3520000048	644000[illegible]	[illegible]	[illegible]
0	129	49	4620000050	7230000048	293000[illegible]	[illegible]	[illegible]
0	129	50	1260000050	1350000049	392000[illegible]	[illegible]	[illegible]

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INPU

Forbidden	A	Z	LAMBD	FU238	FU235	EO	Δ
0	109	43	2770000050	4520000048	2040000047	1416000052	1000000051
0	109	44	4330000049	4180000048	2300000047	9220000051	1000000051
0	109	45	2890000047	1000000048	7600000046	7080000051	1000000051
1	109	46	1380000046	4400000045		2000000051	9900000050
1	110	42	6930000050	4600000047	1300000047	1215000052	1000000051
0	110	43	3460000050	2920000048	1740000047	1972000052	1000000051
0	110	44	6930000049	4230000048	1360000046	5520000051	1000000051
0	110	45	3460000049	1790000048	9000000046	1308000052	1000000051
0	111	43	4620000050	1610000048	5400000046	1600000052	1000000051
1	111	44	1730000050	3780000048	1300000047	1108000052	1000000051
0	111	45	5780000049	2610000048	1098000047	8980000051	1000000051
0	111	46	4440000047	3950000047	2180000046	4300000051	1000000051
0	111	47	1060000045	6000000044		2080000051	9100000050
1						1600000051	1000000049
0						1400000051	8000000049
1	112	43	4620000050	6960000047	2500000046	2146000052	1000000051
0	112	44	2310000050	2960000048	1022000047	7420000051	1000000051
0	112	45	9900000049	3200000048	1146000047	1490000052	1000000051
0	112	46	9170000045	9370000047	3780000046	5000000050	1000000051
0	112	47	6020000046	6200000045	6000000044	8200000051	2500000050
0						7000000051	4000000050
1.						5400000051	2000000050
0						2000000051	1500000050
0	113	44	3460000050	2140000048	9120000046	1280000052	1000000051
0	113	45	1730000050	3440000048	1218000047	1076000052	1000000051
0	113	46	8250000048	1700000048	6300000046	7020000051	1000000051
0	113	47	3630000046	1110000047	4000000045	4200000051	1000000051
0	114	44	4620000050	1110000048	5260000046	9060000051	1000000051
0	114	45	2310000050	3170000048	1124000047	1660000052	1000000051
1	114	46	4810000048	2450000048	8260000046	2720000051	1000000051
0	114	47	5780000048	4680000047	1240000046	1014000052	1000000051
0	115	44	6930000050	4840000047	2420000046	1536000052	1000000051
0	115	45	2770000050	2780000048	8580000046	1254000052	1000000051
1	115	46	1540000049	3080000048	8580000046	8960000051	1000000051
1	115	47	5470000047	1120000050	2420000046	5800000051	1000000051
0	115	48-	1860000044	1400000045		3220000051	9800000050
0						1400000051	2000000049
0	115	48	3630000045			3220000051	5800000050
1						1160000051	4200000050
0	115	49-	4280000046			1660000051	5000000049
0	116	45	3460000050	1720000048	7000000046	1828000052	1000000051
0	116	46	6930000049	3210000048	9500000046	4620000051	1000000051
0	116	47	4620000048	1790000048	4300000046	1000000052	1000000051
0	117	45	4620000050	2410000048	4780000046	1430000052	1000000051
0	117	46	1390000050	3060000048	8700000046	1074000052	1000000051
0	117	47	1050000049	1290000048	5800000046	7580000051	1000000051
0	117	48	7080000046	3300000046	7200000045		1000000051
0	117	49-	1010000047			3540000051	5500000050
0						3240000051	2300000050
0	117	49	1750000047			1480000051	1000000051
0	118	45	4620000050	1970000048	3020000046	1992000052	1000000051
0	118	46	1540000050	3160000048	9000000046	6460000051	1000000051
0	118	47	2770000049	1560000048	8040000046	1364000052	1000000051
0	118	48	2310000047	1020000047	1960000046	1800000050	1000000051

Forbidden	A	Z	LAMBD	FU238	FU235	EO	Δ
0	118	49	1260000050			8800000051	1000000051
0	119	45	4620000050	1060000048	1640000046	1600000052	1000000051
1	119	46	2310000050	3040000048	8240000046	1248000052	1000000051
0	119	47	4080000049	2350000048	1010000047	9360000051	1000000051
0	119	48-	3980000048	2240000047	1120000046	6240000051	1000000051
0	119	48	1160000048	2240000047	1120000046	6240000051	1000000051
0	119	49	6600000047	9700000044	1000000045	5400000051	1000000051
0	120	46	3460000050	2780000048	6760000046	8140000051	1000000051
0	120	47	1160000050	3080000048	1044000047	1526000052	1000000051
0	120	48	9620000047	1120000048	6220000046	1980000051	1000000051
0	120	49	1260000049	1500000046	5600000045	2000000051	1000000051
1	121	46	4620000050	1800000048	4400000046	1408000052	1000000051
0	121	47	1730000050	3350000048	1092000047	1102000052	1000000051
0	121	48	2770000049	1870000048	8920000046	7960000051	1000000051
0	121	49	9240000048	1800000047	1780000046	5900000051	1000000051
0	121	50	7130000045			7660000050	1000000051
0	122	46	4620000050	8800000047	2680000046	9880000051	1000000051
1	122	47	2310000050	3030000048	1096000047	1688000052	1000000051
0	122	48	1730000049	2810000048	1228000047	3800000051	1000000051
0	122	49	1540000049	6800000047	4060000046	1080000052	1000000051
0	123	47	2770000050	2770000048	7756000046	1268000052	1000000051
0	123	48	7700000049	3510000048	1036000047	9660000051	1000000051
0	123	49	2310000049	1480000048	5362000046	7640000051	1000000051
1	123	50	5900000043	3800000046	3360000045	2840000051	1000000051
0	124	47	3460000050	1580000048	5684000046	1854000052	1000000051
0	124	48	6930000049	3690000048	1210000047	5620000051	1000000051
0	124	49	3460000047	2540000048	8904000046	1250000052	1000000051
0	125	47	3460000050	7200000047	3122000046	1440000052	1000000051
0	125	48	1390000050	3340000048	1278000047	1140000052	1000000051
0	125	49	4620000049	3610000048	1432000047	9400000051	1000000051
0	125	50	8530000044	1060000048	4732000046	4740000051	9500000050
0						8000000050	5000000049
0	125	51	1100000043	7000000046	7000000044	1220000051	1400000050
1						6000000050	4500000050
0						8800000050	1200000050
0						2600000050	2900000050
0	126	48	2310000050	3050000048	3684000047	7420000051	1000000051
0	126	49	9900000049	4880000048	4872000047	1404000052	1000000051
0	126	50	2310000047	2410000048	2520000047	1460000051	1000000051
0	126	51	2140000046	1580000047	1540000046	2000000051	1000000051
0	127	48	4620000050	2160000048	4540000047	1302000052	1000000051
0	127	49	2310000050	6160000048	9690000047	1106000052	1000000051
0	127	50	9170000046	4760000048	7130000047	7100000051	1000000051
0	127	51	2190000045	9100000047	1080000047	3140000051	3000000050
0						2220000051	2000000050
0						1720000051	5000000050
1	127	52-	7640000043	3900000044			1000000051
0	127	52	2050000046	1600000045		1400000051	9900000050
0	128	48	6930000050	1270000048	6440000047	9120000051	1000000051
0	128	49	3460000050	7480000048	2296000048	1558000052	1000000051
0	128	50	2030000047	9680000048	2296000048	3240000051	1000000051
0	128	51	1120000048	3520000048	6440000047	5800000051	1000000051
0	129	49	4620000050	7230000048	2930000048	1268000052	1000000051
0	129	50	1260000050	1350000049	3920000045	8760000051	1000000051

Forbidden	A	Z	LAMBD	FU238	FU235	EO	Δ	Forbidden
0	129	51	4580000046	7540000048	2020000048	3740000051	2000000050	.0
0						3400000051	2000000050	0
0						3120000051	2000000050	0
1						2680000051	2000000050	0
0						2160000051	2000000050	0
0	129	52-	2390000044	1550000047	6000000046		1000000051	0
0	129	52	1600000047	5800000047	7000000046	5800000050	1000000050	1
0						1380000051	4000000049	0
0						1480000051	1500000050	0
0						2900000051	7100000050	0
0	130	49	4620000050	4180000048	3840000048	1742000052	1000000051	0
0	130	50	4440000048	1480000049	8210000048	5340000051	1000000051	0
1	130	51	1630000048	1370000049	6040000048	1158000052	1000000051	0
0	131	49	6930000050	2430000048	2700000048	1462000052	1000000051	1
0	131	50	3400000048	1490000049	1110000049	1072000052	1000000051	0
0	131	51	5000000047	1890000049	1270000049	7040000051	1000000051	0
0	131	52-	6420000045	3990000047	2100000048	8400000050	5200000050	0
0						1140000051	1700000050	.0
0						1960000051	4600000049	0
1						4920000051	4700000049	0
0	131	52	4620000047	7580000048	2100000048	2700000051	1500000050	0
0						2380000051	2500000050	0
0						4280000051	6000000050	0
0	131	53	9900000046	2060000047	1030000047	8000000050	2800000049	1
0						1630000051	7000000048	0
0						1216000051	8720000050	0
0						6700000050	9300000049	0
0	132	50	8250000048	9080000048	1130000049	7040000051	1000000051	0
0	132	51	5500000048	2110000049	1740000049	1312000052	1000000051	0
1	132	52	2480000045	1460000049	1040000049	6000000050	1000000051	0
0	132	53	8520000046	2210000048	9000000047	4240000051	1800000050	1
0						3060000051	2400000050	0
0						2320000051	2300000050	0
0						1800000051	2000000050	0
0	133	50	3470000050	4440000048	8600000048	1258000052	1000000051	0
1	133	51	2620000048	1940000049	2610000049	8920000051	1000000051	0
0	133	52-	1830000047	1050000049	1190000049	6860000051	1000000051	0
0	133	52-	1830000047			6460000051	1000000051	0
0	133	52	5780000048	1050000049	1190000049	4800000051	3000000050	0
0						2600000051	7000000050	0
0	133	53	9250000045	6120000048	4400000048	2600000051	9100000050	1
0						8000000050	9000000049	0
0	133	54-	3490000045	1000000048			1000000051	0
0	133	54	1520000045	3900000046		7000000050	1000000051	1
0	134	51	[illegible]	1670000049	2710000049	1518000052	1000000051	0
0	134	52	[illegible]	2480000049	3200000049	3580000051	1000000051	0
0	134	53	2200000047	1190000049	1440000049	5000000051	9000000050	1
1						3000000051	5000000050	0
c	135	51	1160000050	1010000049	1220000049	1114000052	1000000051	0
1	135	52	5780000048	2510000049	2590000049	9000000051	1000000051	0
0	135	53	2880000046	1810000049	1910000049	1000000051	3500000050	1
0						2000000051	4000000050	0
0						2800000051	2500000050	0
1	135	54-	7400000047	9300000047	1400000048		1000000051	0

Forbidden	A	Z	LAMBD	FU238	FU235	EO	Δ	Forbidden
:	139	54	2110000046	2170000048	1400000048	1100000051	3000000049	1
0						1820000051	9700000050	0
0	136	51	2310000050	4230000048	5400000048	1716000052	1000000051	0
0	136	52	1160000050	1980000049	2230000049	5800000051	1000000051	0
0	136	53	8060000048	2430000049	2490000049	1400000052	2500000050	0
0						1120000052	2500000050	0
0						8400000051	2500000050	0
0						5400000051	2500000050	0
0	136	55	6220000044	2730000047	3038000047	6820000050	9300000050	1
0						1314000051	7000000049	0
0	137	52	2310000050	3040000048	1750000049	1102000052	1000000051	0
0	137	53	3150000049	1840000049	2700000049		1000000051	0
0	137	53	3150000049	1835000049	2704000049	1300000052	1000000051	0
0	137	54	2960000048	2380000049	1500000049	7000000051	1000000051	0
0	137	55	8260000041	8640000049	1300000048	1020000051	9200000050	1
0						2340000051	8000000049	0
0	138	52	3460000050	7740000048	8600000048	8140000051	1000000051	0
0	138	53	1170000050	1180000049	2580000049	1378000052	1000000051	0
0	138	54	6790000047	2390000049	2300000049	4800000051	1000000051	0
0	138	55	3590000047	1460000049	5600000048	6800000051	7300000050	1·
0						5300000051	1800000050	0
0	139	53	2570000050	5970000048	2050000049	1088000052	1000000051	0
0	139	54	1690000049	1990000049	2740000049	8160000051	1000000051	0
1	139	55	1220000048	1860000049	1420000049	4400000051	1000000051	0
0	139	56	1380000047	4510000048	9000000047	4760000051	1500000050	0
0						4460000051	6600000050	0
0						1640000051	1900000050	0
0	140	53	4620000050	7560000048	8400000048	1626000052	1000000051	0
0	140	54	4330000049	1550000049	2490000049	5340000051	1000000051	0
0	140	55	1050000049	2090000049	2230000049	1086000052	1000000051	0
1	140	56	6270000044	9200000048	5400000048	2000000051	7500000050	0
0						8000000050	2500000050	0
1	140	57	4790000045	3700000047		4400000051	8000000049	1
0						3240000051	1400000050	0
0						2720000051	3000000050	0
0						2300000051	2000000050	0
0						1720000051	1200000050	0
0						8400000050	1600000050	0
0	141	54	4080000050	7230000048	1960000049	1072000052	1000000051	0
1	141	55	7700000049	1920000049	2610000049	8040000051	1000000051	0
0	141	56	6420000047	1420000049	1380000049	5600000051	1000000051	0
0	141	57	5070000046	2360000048	8000000047	4860000051	9500000050	0
0						1800000051	5000000049	0
1	141	58	2420000044	4700000045		1160000051	300[illegible]	0
0						8800000050	700[illegible]	
0	142	54	4620000050	3090000048	8100000048	7960000051	100[illegible]	
0	142	55	1160000049	1440000049	2410000049	1530000052	100[illegible]	
0	142	56	1920000048	1640000049	2150000049	2640000051	100[illegible]	
0	142	57	1500000047	5070000048	5200000048	8000000051	100[illegible]	
0	143	55	3460000050	9380000048	1820000049	1056000052	100[illegible]	
0	143	56	1160000050	1690000049	2440000049	7920000051	100[illegible]	
0	143	57	6080000047	9000000048	1260000049	6000000051	100[illegible]	
0	143	58	5830000045	7200000047	8000000047	2800000051	37[illegible]	
0						2260000051	40[illegible]	
						1480000051	50[illegible]	
						1000000051	12[illegible]	

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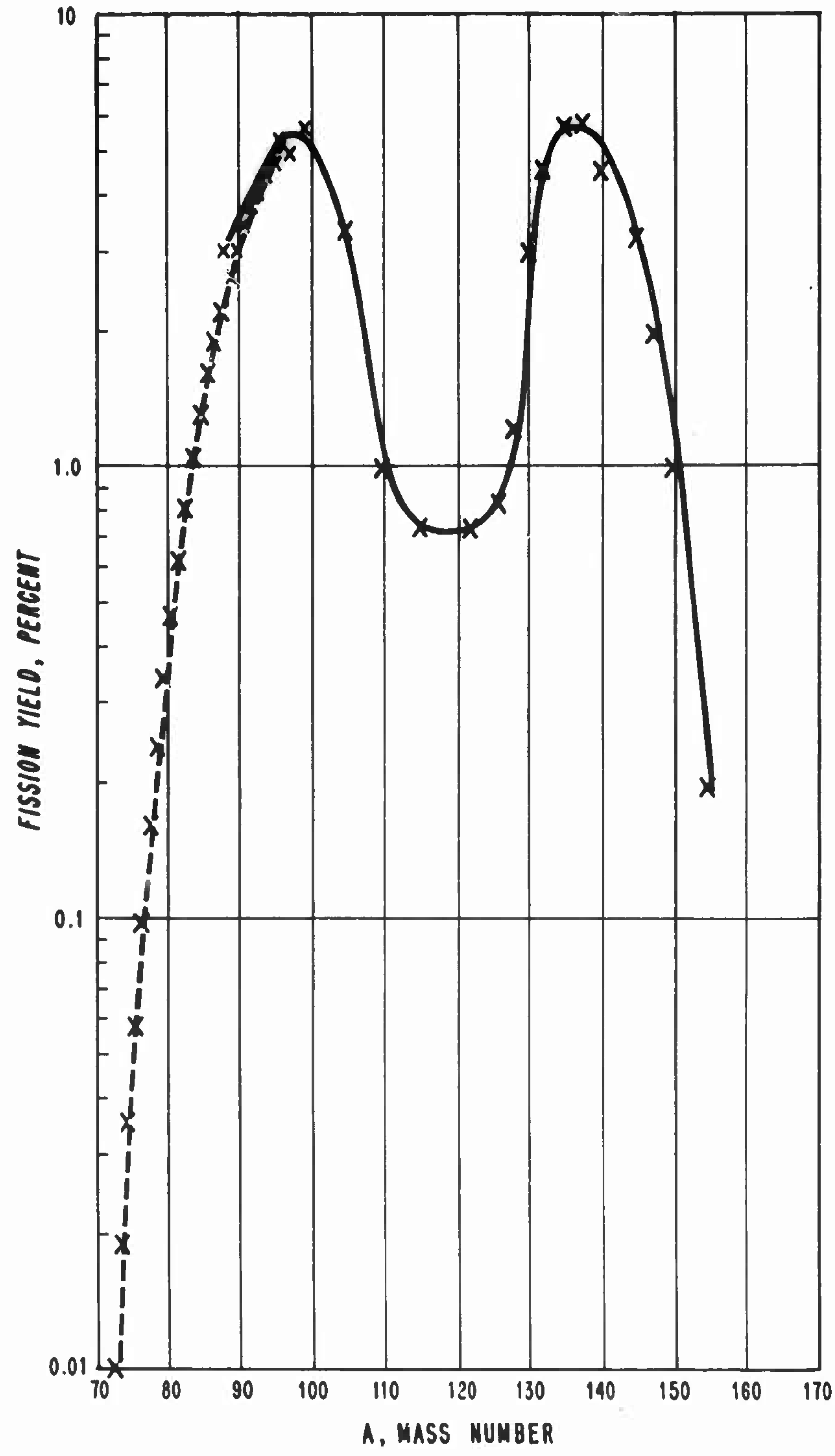
TABLE II

INPUT DATA CHARACTERISTICS U^{235} AND U^{238}

Z	LAMBD	FU238	FU235	E0	Δ	Forbidden
51	4580000046	7540000048	2020000048	3740000051	2000000050	0
				3400000051	2000000050	0
				3120000051	2000000050	0
				2680000051	2000000050	0
				2160000051	2000000050	0
52-	2390000044	1550000047	6000000046		1000000051	0
52	1600000047	5800000047	7000000046	5800000050	1000000050	1
				1380000051	4000000049	0
				1480000051	1500000050	0
				2900000051	7100000050	0
49	4620000050	4180000048	3840000048	1742000052	1000000051	0
50	4440000048	1480000049	8210000048	5340000051	1000000051	0
51	1630000048	1370000049	6040000048	1198000052	1000000051	0
49	6930000050	2430000048	2700000048	1462000052	1000000051	1
50	3400000048	1490000049	1110000049	1072000052	1000000051	0
51	5000000047	1890000049	1270000049	7040000051	1000000051	0
52-	6420000045	3990000047	2100000048	8400000050	5200000050	0
				1140000051	1700000050	0
				1960000051	4600000049	0
				4920000051	4700000049	0
52	4620000047	7580000048	2100000048	2700000051	1580000050	0
				2380000051	2800000050	0
				4280000051	6000000050	0
53	9900000046	2060000047	1000000047	9000000050	2800000049	1
				1630000051	7000000048	0
				1216000051	8720000050	0
				6700000050	9300000049	0
50	5250000046	9080000048	1130000049	7040000051	1000000051	0
51	5500000048	2110000049	1740000049	1312000052	1000000051	0
52	2480000045	1460000049	1040000049	6000000050	1000000051	0
53	8520000046	2210000048	9000000047	4240000051	1800000050	1
				3060000051	2400000050	0
				2320000051	2300000050	0
				1800000051	2000000050	0
50	3470000050	4440000048	8600000048	1258000052	1000000051	0
51	2620000048	1940000049	2610000049	8920000051	1000000051	0
52-	1830000047	1050000049	1190000049	6860000051	1000000051	0
52-	1830000047			6860000051	1000000051	0
52	5780000048	1050000049	1190000049	4800000051	3000000050	0
				2600000051	7000000050	0
53	9250000045	6120000048	4400000048	2600000051	9100000050	1
				8000000050	9000000049	0
54-	3490000045	1000000045			1000000051	0
54	1520000045	3900000046		7000000050	1000000051	1
51	1390000049	1470000049	2710000049	1518000052	1000000051	0
52	2620000047	2480000049	3200000049	3880000051	1000000051	0
53	2200000047	1190000049	1440000049	5000000051	5000000050	1
				3000000051	5000000050	0
51	1160000050	1010000049	1220000049	1114000052	1000000051	0
52	5780000048	2510000049	2590000049	9000000051	1000000051	0
53	2880000046	1810000049	1910000049	1000000051	3500000050	1
				2000000051	4000000050	0
				2800000051	2500000050	0
54-	7400000047	9300000047	1400000048		1000000051	0
Z	LAMBD	FU238	FU235	E0	Δ	Forbidden
54	2110000046	2170000048	1400000048	1100000051	3000000049	1
				1820000051	9700000050	0
51	2310000050	4230000048	5400000048	1716000052	1000000051	0
52	1160000050	1980000049	2230000049	9800000051	1000000051	0
53	8060000048	2430000049	2490000049	1400000052	2500000050	0
				1120000052	2800000050	0
				8400000051	2500000050	0
				5400000051	2500000050	0
55	6220000044	2730000047	3038000047	6820000050	9300000050	1
				1314000051	7000000049	0
52	2310000050	3040000048	1780000049	1102000052	1000000051	0
53	3150000049	1840000049	3700000049		1000000051	0
53	3150000049	1835000049	2704000049	1300000052	1000000051	0
54	2960000048	2380000049	1500000049	7000000051	1000000051	0
55	8260000041	8640000049	1300000048	1020000051	9200000050	1
				2340000051	8000000049	0
52	3460000050	7740000048	8600000048	8140000051	1000000051	0
53	1170000050	1180000049	2580000049	1378000052	1000000051	0
54	6790000047	2390000049	2300000049	4800000051	1000000051	0
55	3590000047	1460000049	5600000048	6800000051	7300000050	1
				5300000051	1800000050	0
53	2570000050	5970000048	2050000049	1088000052	1000000051	0
54	1690000049	1990000049	2740000049	8160000051	1000000051	0
55	1220000048	1860000049	1420000049	4400000051	1000000051	0
56	1380000047	4510000048	9000000047	4760000051	1500000050	0
				4460000051	6600000050	0
				1640000051	1900000050	0
53	4620000050	7560000048	8400000048	1626000052	1000000051	0
54	4330000049	1550000049	2490000049	5340000051	1000000051	0
55	1050000049	2090000049	2230000049	1086000052	1000000051	0
56	6270000044	9200000048	5400000048	2000000051	7500000050	0
				8000000050	2500000050	0
57	4790000045	3700000047		4400000051	8000000049	1
				3240000051	1400000050	0
				2720000051	3000000050	0
				2300000051	2000000050	0
				1720000051	1200000050	0
				8400000050	1600000050	0
54	4080000050	7230000048	1950000049	1072000052	1000000051	0
55	7700000049	1920000049	2610000049	8040000051	1000000051	0
56	6420000047	1420000049	1360000049	5600000051	1000000051	0
57	5070000046	2360000048	8000000047	4860000051	9800000050	0
				1800000051	5000000049	0
58	2420000044	4700000045		1160000051	3000000050	0
				8800000050	7000000050	0
54	4620000050	3090000048	8100000048	7960000051	1000000051	0
55	1160000049	1440000049	2410000049	1330000052	1000000051	0
56	1920000048	1640000049	2150000049	2840000051	1000000051	0
57	1500000047	5070000048	5200000048	8000000051	1000000051	0
55	3460000050	9380000048	1820000049	1056000052	1000000051	0
56	1160000050	1690000049	2440000049	7920000051	1000000051	0
57	6080000047	9000000048	1260000049	6000000051	1000000051	0
58	5830000045	7200000047	8000000047	2800000051	3700000050	1
				2260000051	4000000050	0
				1480000051	5000000049	0
				1000000051	1200000050	0

A	Z	LAMBD	FU238	FU235	E0	Δ	Forbidden
					4000000050	6000000049	0
143	59	5830000044			1860000051	1000000051	0
144	55	4620000050	4720000048	6800000048	1546000052	1000000051	0
144	56	1980000050	1420000049	2050000049	4960000051	1000000051	0
144	57	4620000049	1160000049	1820000049	1022000052	1000000051	0
144	58	2810000043	2480000048	4500000048	6800000050	7800000050	0
					5000000050	5000000049	0
					3400000050	2000000050	0
144	59	6690000047	3600000045		6000000051	9500000050	0
					4600000051	2000000049	0
					1600000051	3000000049	0
145	55	6930000050	1670000048	1856000048	1274000052	1000000051	0
145	56	3460000050	9280000048	1430000049	1014000052	1000000051	0
145	57	7700000049	1290000049	1910000049	8240000051	1000000051	0
145	58	3850000048	5050000048	9900000048	4000000051	1000000051	0
145	59	3240000046	1000000047	6000000047	3400000051	1000000051	1
146	56	4620000050	5690000048	6400000048	7400000051	1000000051	0
146	57	1730000050	1150000049	1600000049	1256000052	1000000051	0
146	58	8310000047	7000000048	1300000049	1800000051	1000000051	0
146	59	4730000047	8000000047	2600000048	7400000051	7500000050	0
					4600000051	2500000050	0
147	56	6930000050	2420000048	2689000048	1244000052	1000000051	0
147	57	3460000050	8880000048	1060000049	1060000052	1000000051	0
147	58	7700000049	8580000048	1250000049	7760000051	1000000051	0
147	59	2890000048	2410000048	5700000048	5520000051	1000000051	0
147	60	7230000044	1200000046	2000000047	1640000051	6000000050	1
					1200000051	1500000050	0
					7600000050	2500000050	0
147	61	8320000042			4800000050	1000000051	0
148	57	3460000050	2740000048	4440000048	1486000052	1000000051	0
148	58	9900000049	8180000048	9500000048	4780000051	1000000051	0
148	59	8660000048	6630000048	7000000048	9820000051	1000000051	0
149	57	4620000050	9200000047	1250000048	1270000052	1000000051	0
149	58	1990000050	5440000048	5110000048	9800000051	1000000051	0
149	59	2310000049	7040000048	5730000048	7700000051	1000000051	0
149	60	9620000046	2560000048	1890000048	3000000051	3330000050	1
					2200000051	3330000050	0
					1900000051	3330000050	0
149	61	3560000045	3500000046	3000000046	2000000051	1000000051	1
150	58	2770000050	2960000048	2540000048	6820000051	1000000051	0
150	59	4620000049	5980000048	3920000048	1148000052	1000000051	0
150	61	7130000046	4200000047	2070000047	6100000051	2000000050	0
					4020000051	8000000050	0
151	58	3460000050	1300000048	6800000047	1090000052	1000000051	0
151	59	9900000049	4420000048	2080000048	9140000051	1000000051	0
151	60	7700000047	3880000048	1830000048	3860000051	1000000051	0
151	61	7000000045	6900000047	4500000047	2200000051	1000000051	1
151	62	2360000041	2800000045		1520000050	1000000051	1
152	58	4620000050	3500000047	3880000047	7980000051	1000000051	0
152	59	1390000050	2320000048	1130000048	1286000052	1000000051	0
152	60	3850000048	3380000048	1340000048	3020000051	1000000051	0
152	61	1920000047	1420000048	6000000047	7900000051	1000000051	0
153	59	2310000050	1610000048	3820000047	1054000052	1000000051	0
153	60	3850000049	2390000048	6960000047	7380000051	1000000051	0
153	61	1280000048	1140000048	4640000047	5620000051	1000000051	0
153	62	4100000045	5700000046	5800000046	1640000051	2000000050	0
					1440000051	4000000050	0
A	Z	LAMBD	FU238	FU235	E0	Δ	Forbidden
					1300000051	4000000050	0
154	59	3460000050	5600000047	9000000046	1434000052	1000000051	0
154	60	5780000049	1590000048	3200000047	4700000051	1000000051	0
154	61	3850000048	1220000048	3200000047	9460000051	1000000051	0
155	59	3460000050	1800000047	2000000047	1232000052	1000000051	0
155	60	1390000050	8800000047	1170000047	9200000051	1000000051	0
155	61	1160000049	1080000048	1380000047	7480000051	1000000051	0
155	62	4910000047	3500000047	6200000046	3400000051	1000000051	0
155	63	1290000043	3700000045	2000000045	3080000050	8000000050	1
					4860000050	2000000050	0
156	60	1940000050	4000000047	3430000046	6380000051	1000000051	0
156	61	2770000049	7400000047	7340000046	1104000052	1000000051	0
156	62	2140000046	4200000047	5410000046	1800000051	1000000051	0
156	63	5210000044	4000000046	8200000045	4800000051	4000000050	1
					1000000051	6000000050	0
157	60	3460000050	1200000047	1000000046	1032000052	1000000051	0
157	61	5330000049	4200000047	3030000046	8620000051	1000000051	0
157	62	5780000048	3700000047	2700000046	5820000051	1000000051	0
157	63	1250000046	8500000046	6600000045	2000000051	7500000050	1
					3400000051	2500000050	0
158	60	3460000050	2500000046	2778000046	7560000051	1000000051	0
158	61	1160000050	1900000047	1090000046	1212000052	1000000051	0
158	62	7700000047	2700000047	1300000046	2760000051	1000000051	0
158	63	1920000047	1100000047	5900000045	5200000051	1000000051	0
159	61	1980000050	7500000046	2230000045	9820000051	1000000051	0
159	62	4950000049	1600000047	4750000045	6720000051	1000000051	0
159	63	5780000047	1000000047	3500000045		1000000051	0
159	64	1070000046	1400000046	5300000044	1900000051	8000000050	1
					1200000051	2000000050	0
160	61	2770000050	2000000046	5100000044	1294000052	1000000051	0
160	62	4620000049	7600000046	1550000045	3700000051	1000000051	0
160	63	9900000048	8000000046	1390000045	8200000051	1000000051	0
160	65	1110000044	1600000044	1778000044	1740000051	3600000050	1
					1160000051	4200000050	
					9200000050	2200000050	0
					3510000051	4000000047	0
161	62	1730000050	2500000046	3700000044	7620000051	1000000051	0
161	63	3150000049	4900000046	3780000044	5640000051	1000000051	0
161	64	3210000048	2400000046	149[illegible]0044	3000000051	1000000051	0
161	65	1170000045	1600[illegible]045	36[illegible]0042	1140000051	1400000050	1
					1040000051	4200000050	0
					9900000050	2300000050	0
					8800000050	2100000050	0

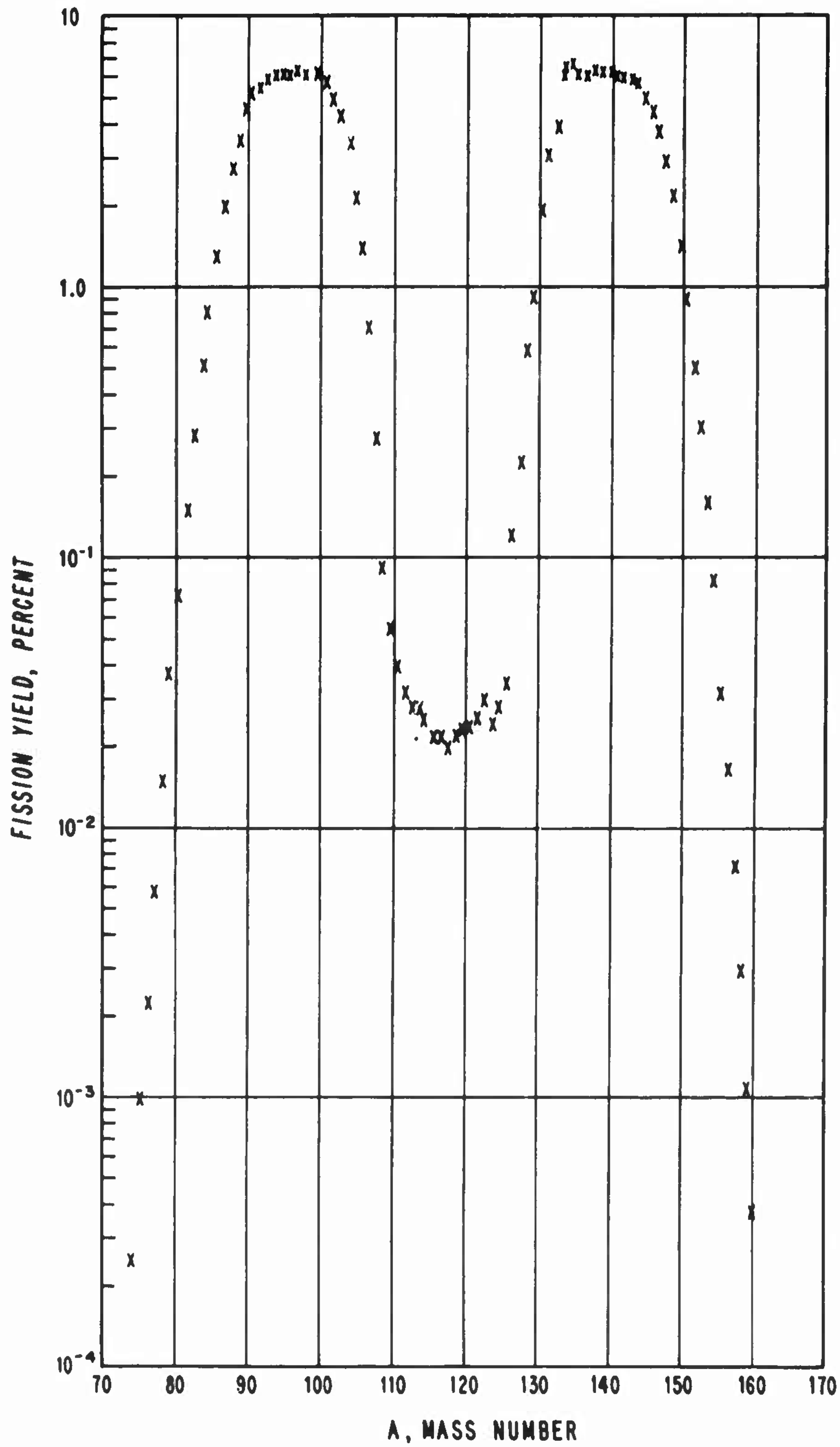
MASS YIELD FROM 14 MEV NEUTRON FISSION OF U^{238}



6-28-60-1

FIGURE 1
WSEG RM 19

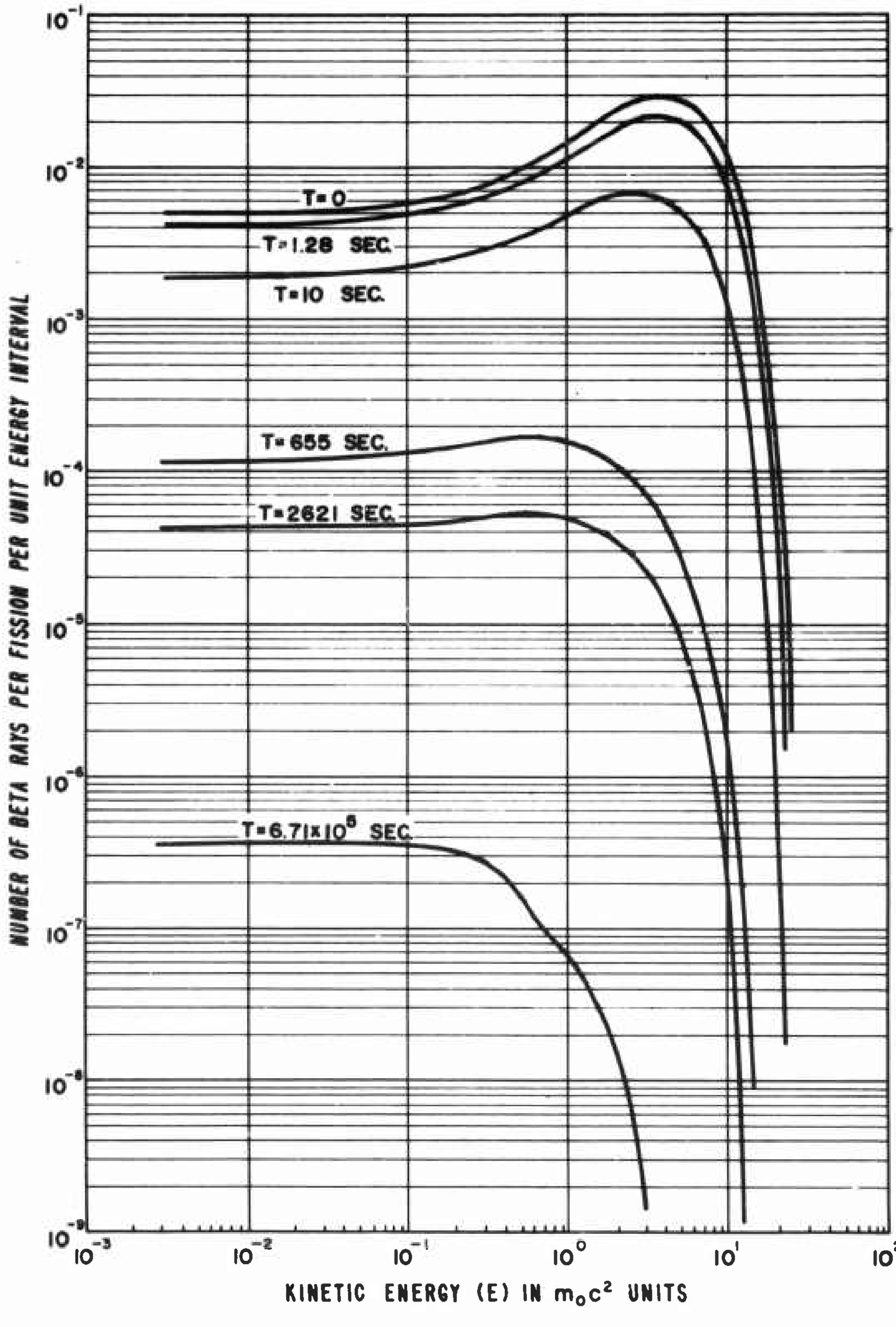
MASS YIELD FROM FISSION SPECTRUM NEUTRON FISSION OF U^{235}



6-28-60-2

FIGURE 2
WSEG RM 19

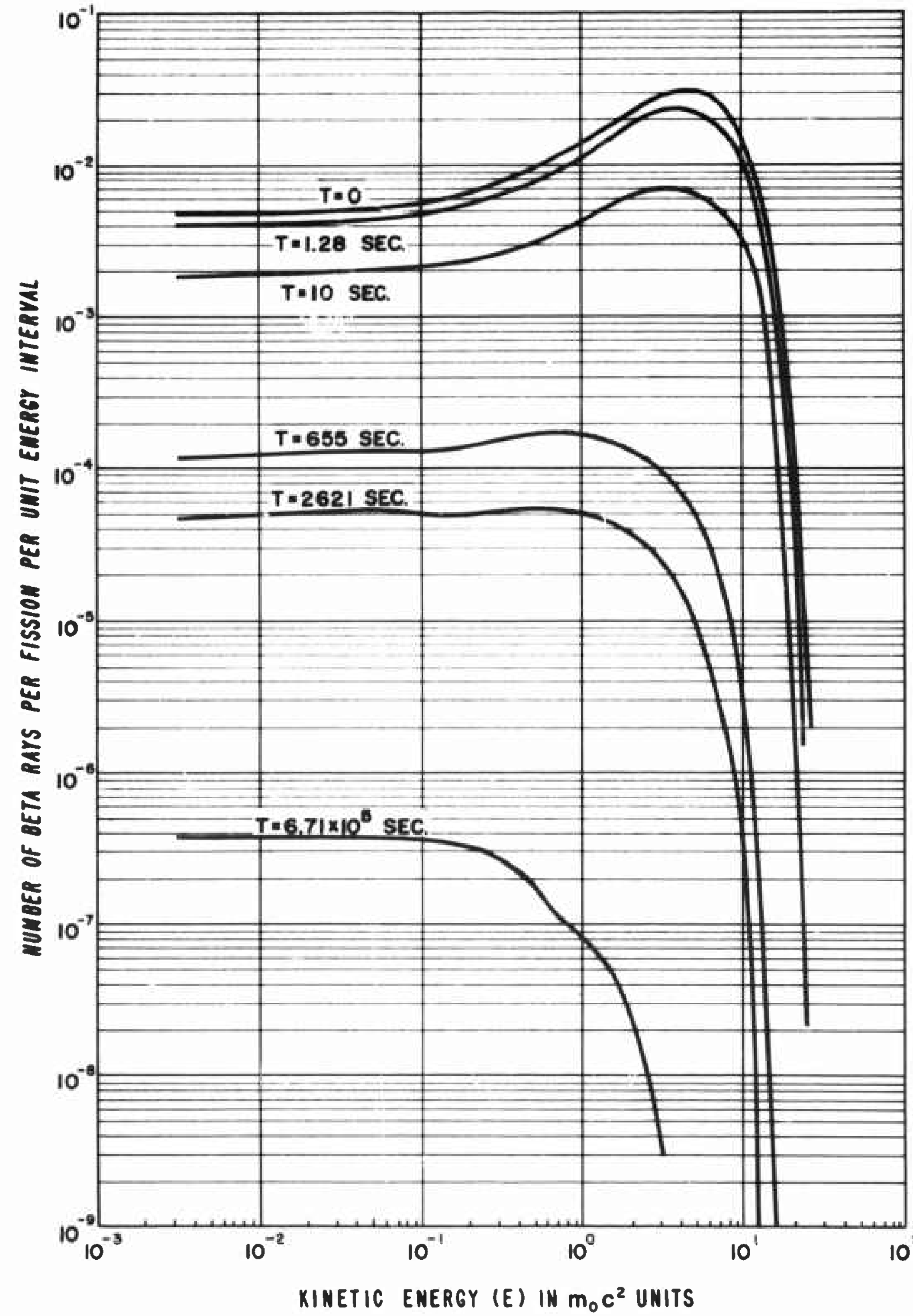
THE BETA RAYS FROM U^{235} FISSION BY FISSION SPECTRUM NEUTRONS



7-29-60-6

FIGURE 3
WSEG RM 19

THE BETA RAYS FROM 14 MEV NEUTRON FISSION OF U^{238}



7-29-60-7

FIGURE 4
WSEG RM 19

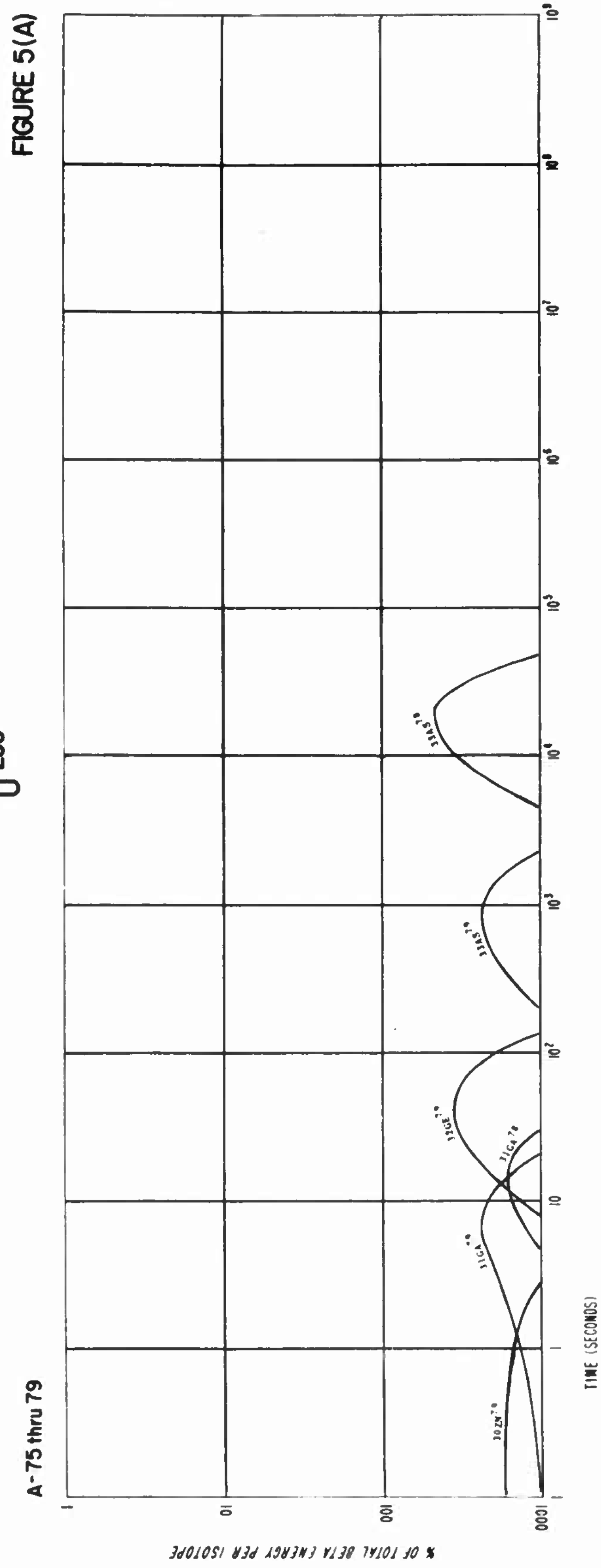


FIGURE 5(A)
U 235
A-75 thru 79
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

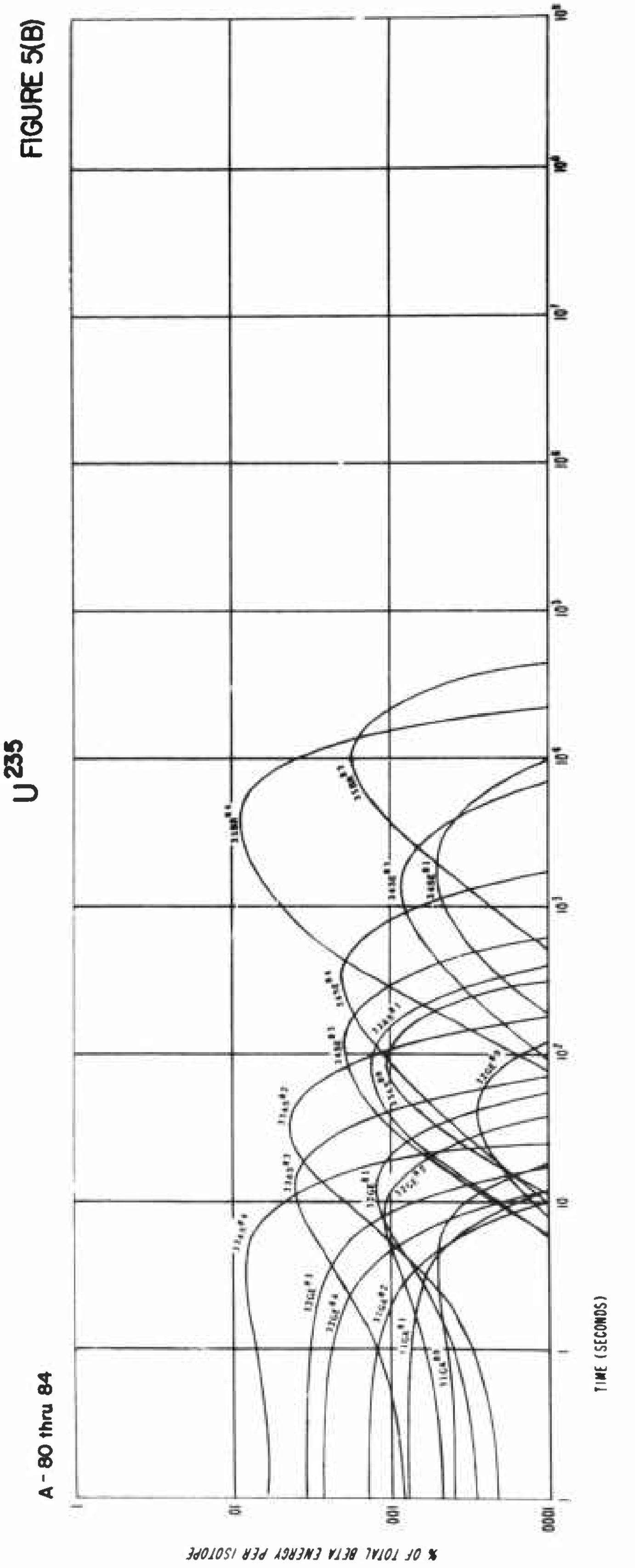


FIGURE 5(B)
U 235
A-80 thru 84
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

8-22-60-1

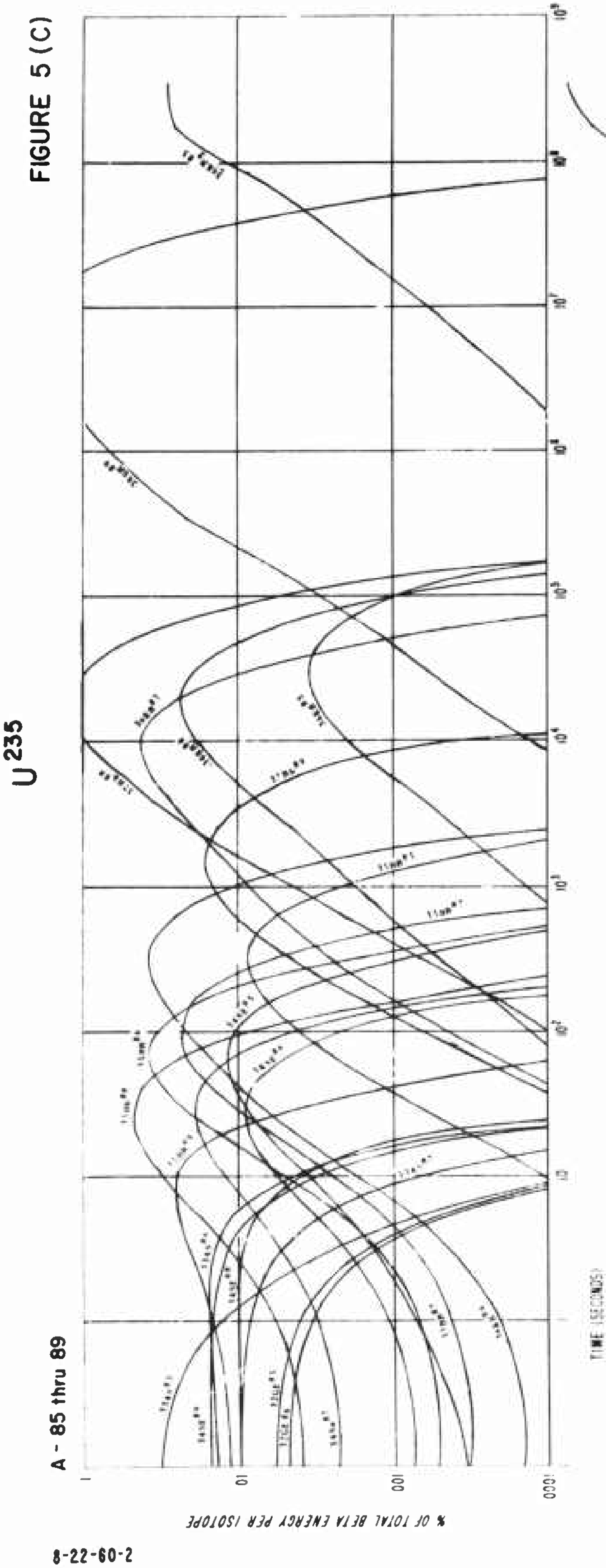


FIGURE 5 (C)
U235
A - 85 thru 89
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

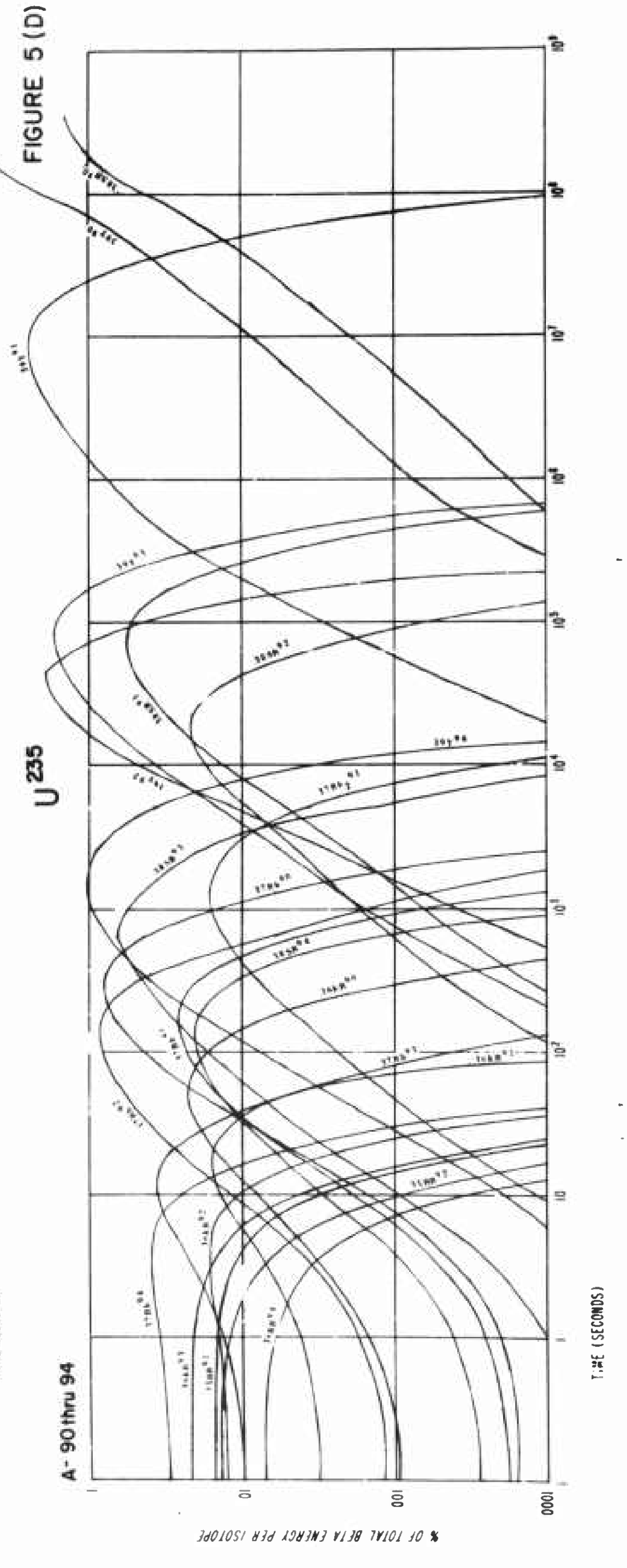


FIGURE 5 (D)
U235
A - 90 thru 94
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

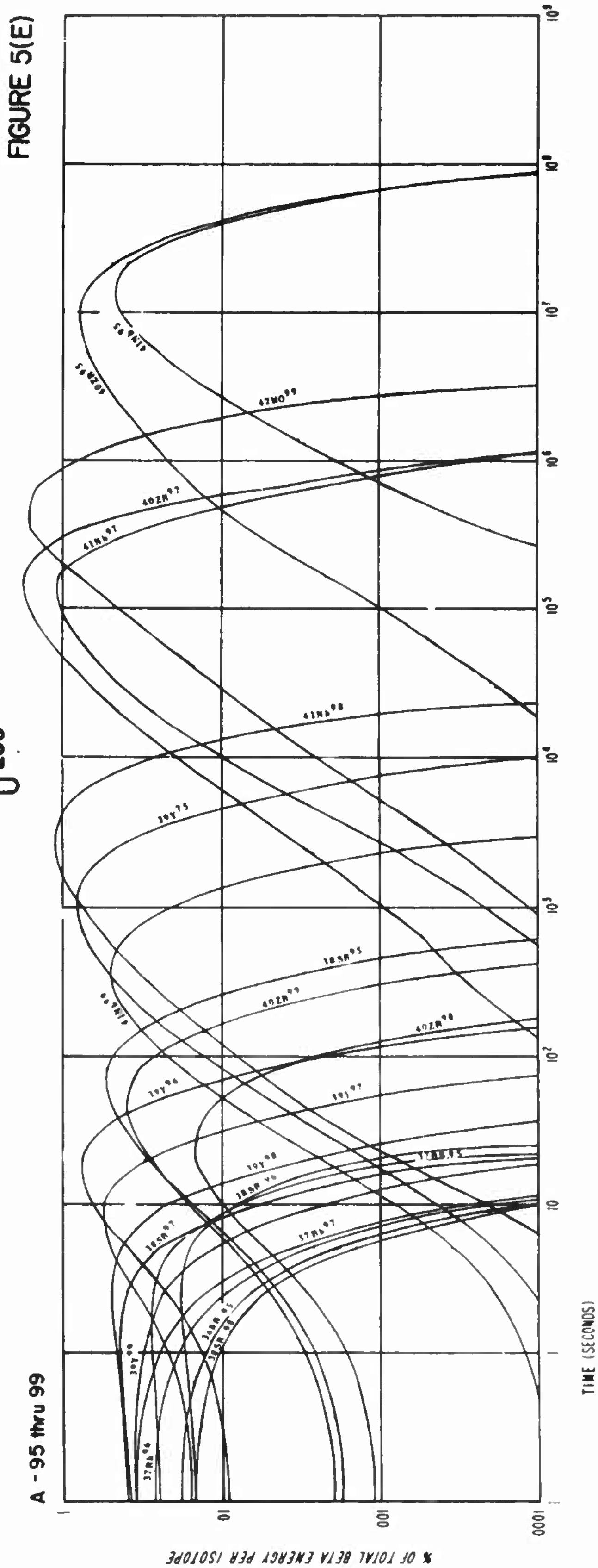


FIGURE 5(E)
U 235
A - 95 thru 99
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

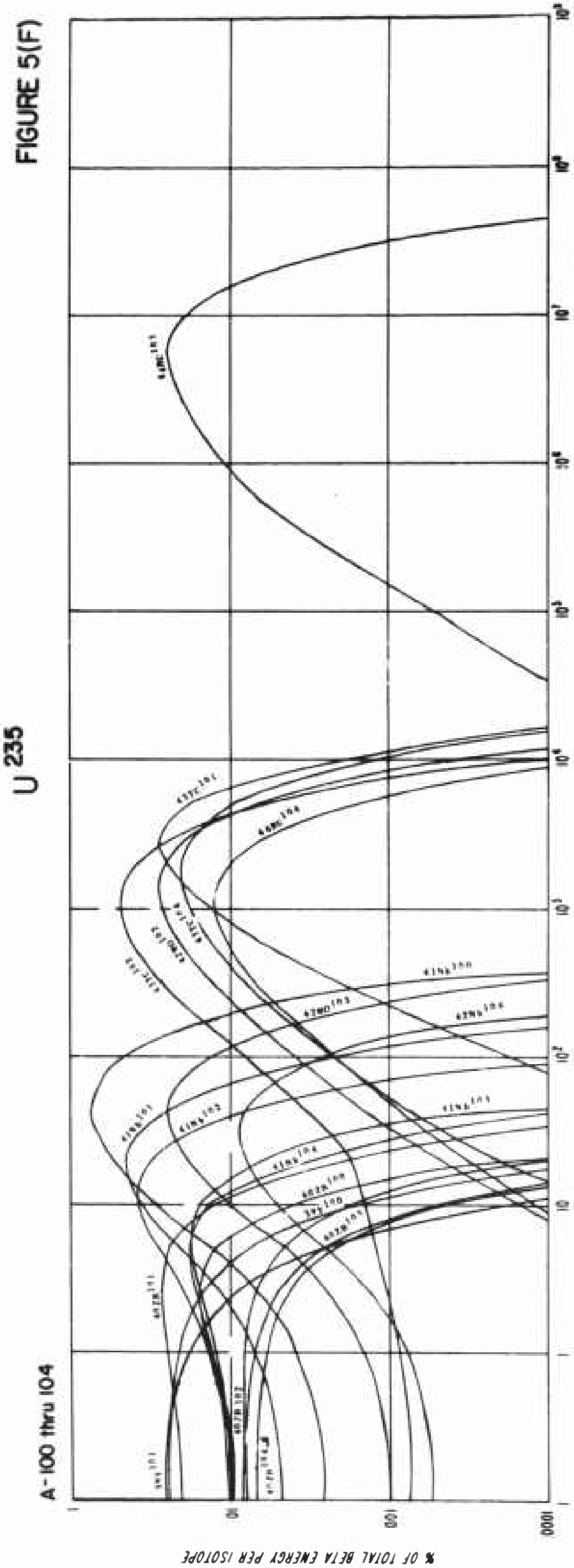


FIGURE 5(F)
U 235
A - 100 thru 104
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

8-22-60-3

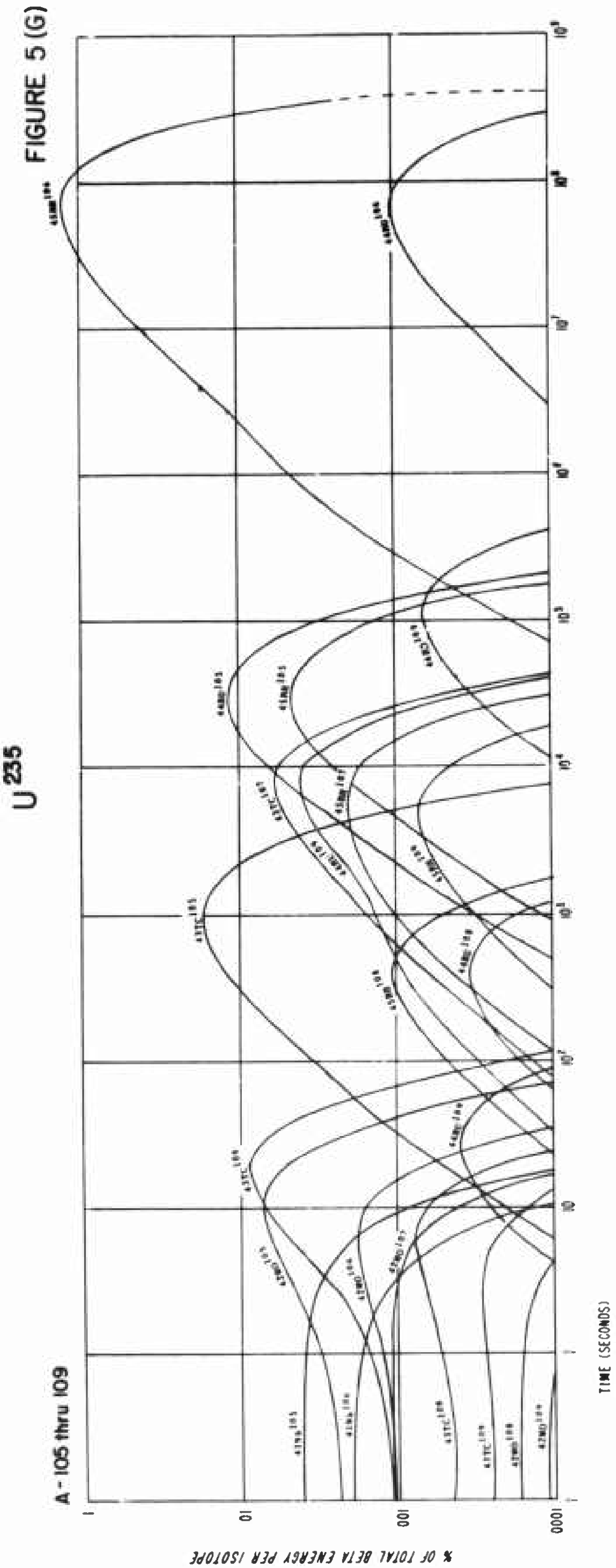


FIGURE 5 (G)
U 235
A - 105 thru 109
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

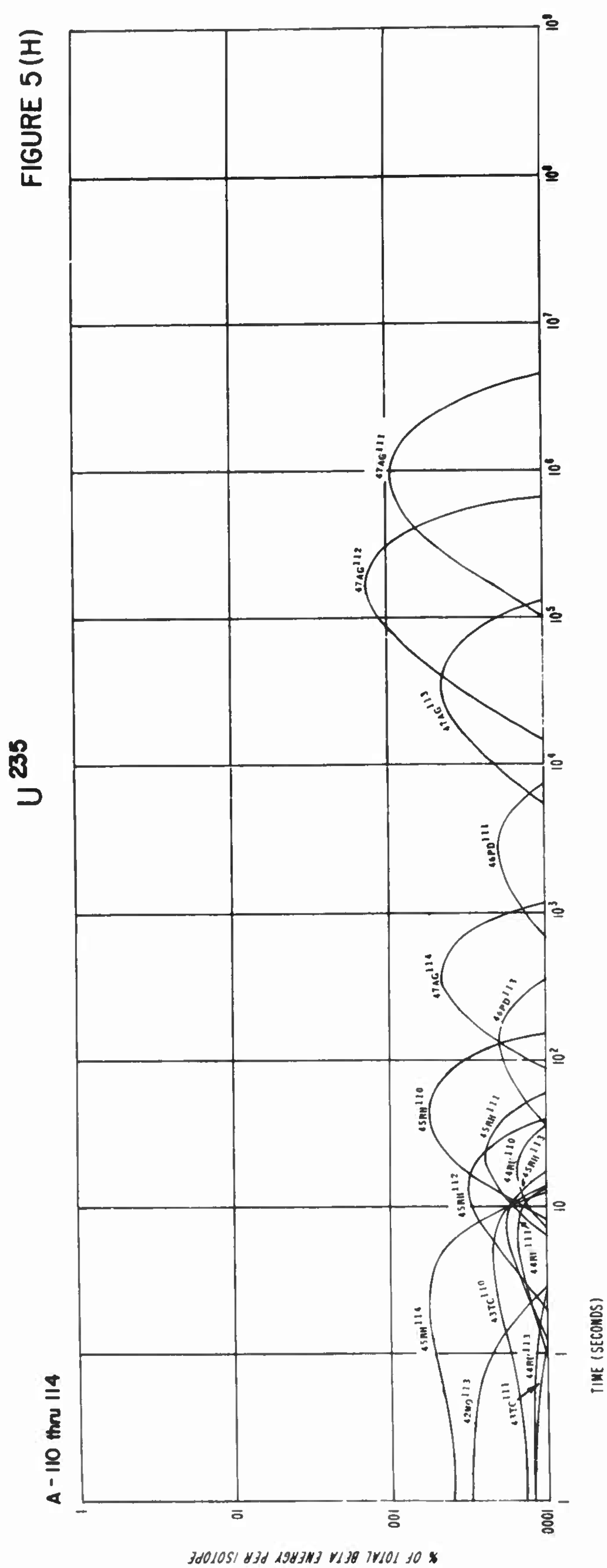


FIGURE 5 (H)
U 235
A - 110 thru 114
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

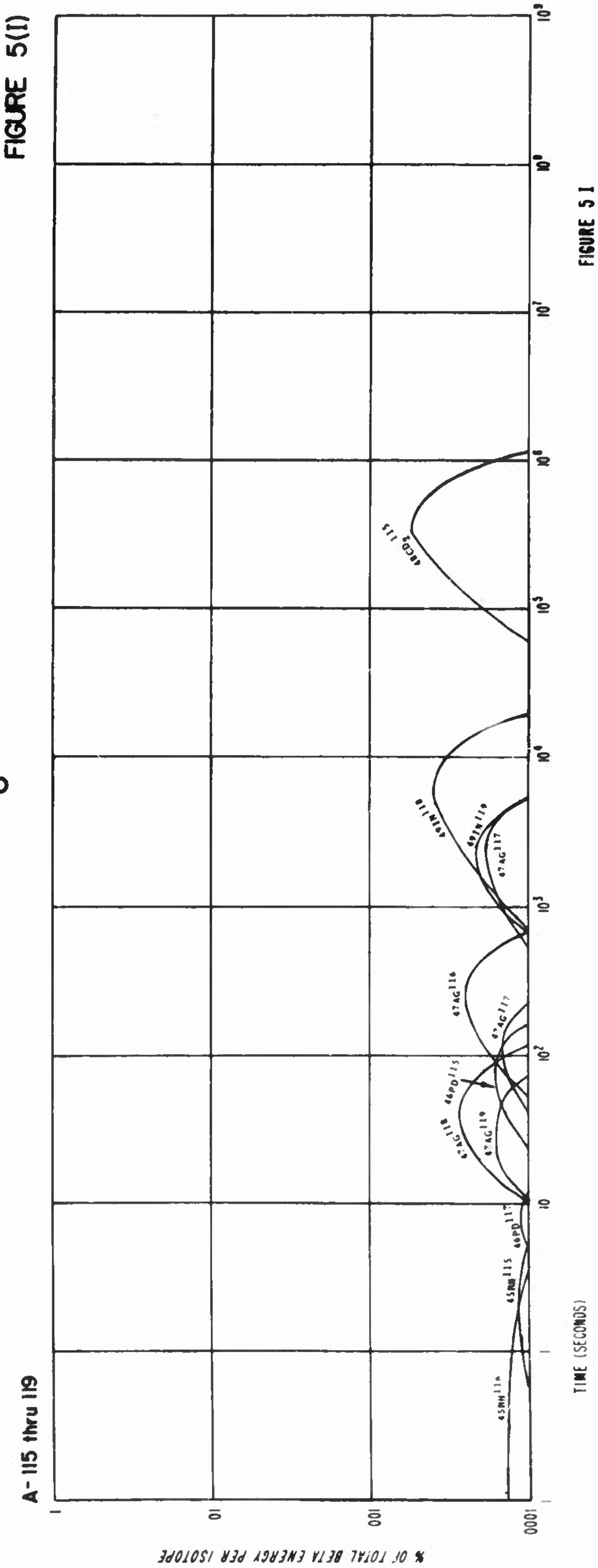


FIGURE 5(I)
U 235
A-115 thru 119
FIGURE 5 I
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

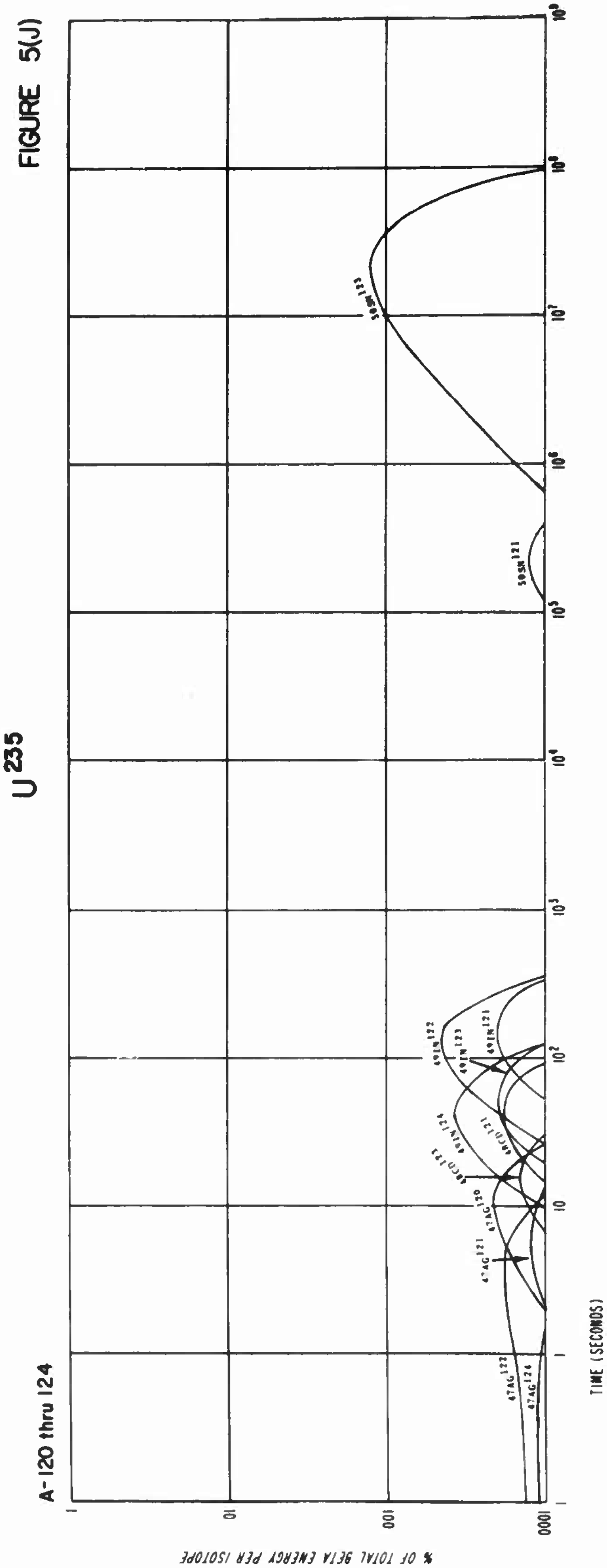


FIGURE 5(J)
U 235
A-120 thru 124
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

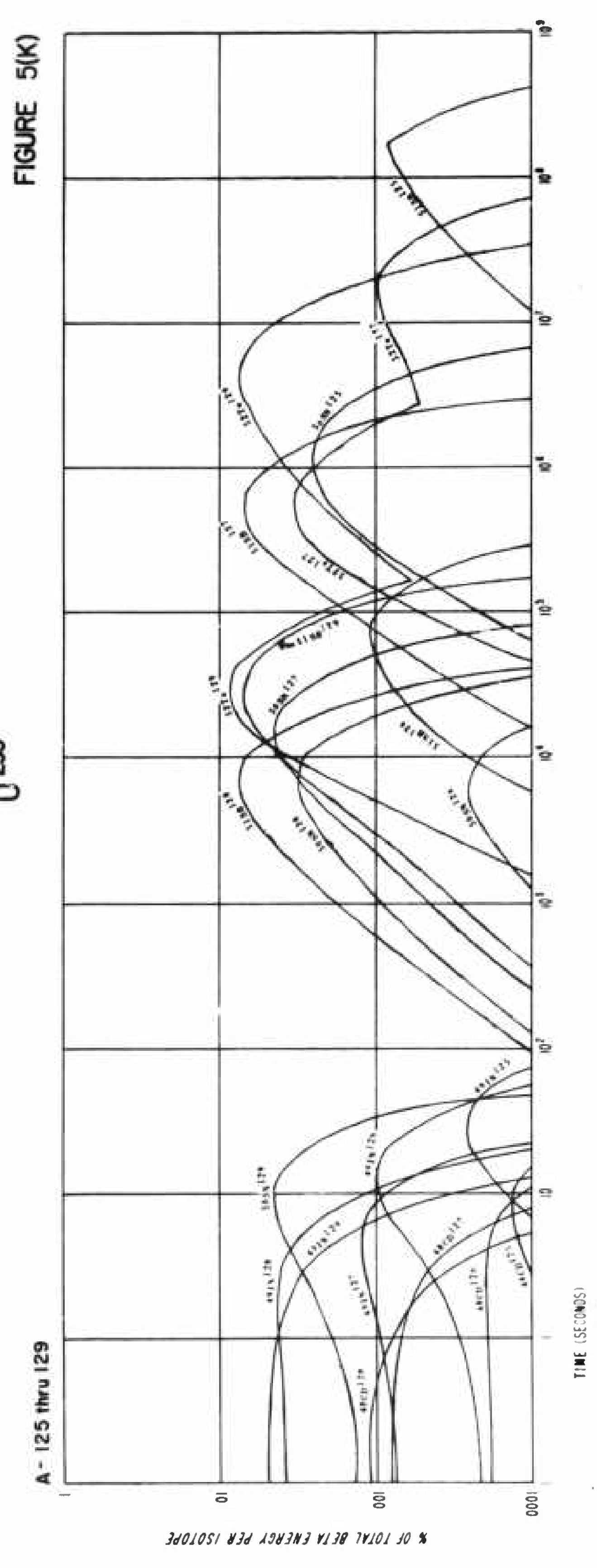


FIGURE 5(K)
U 235
A - 125 thru 129
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

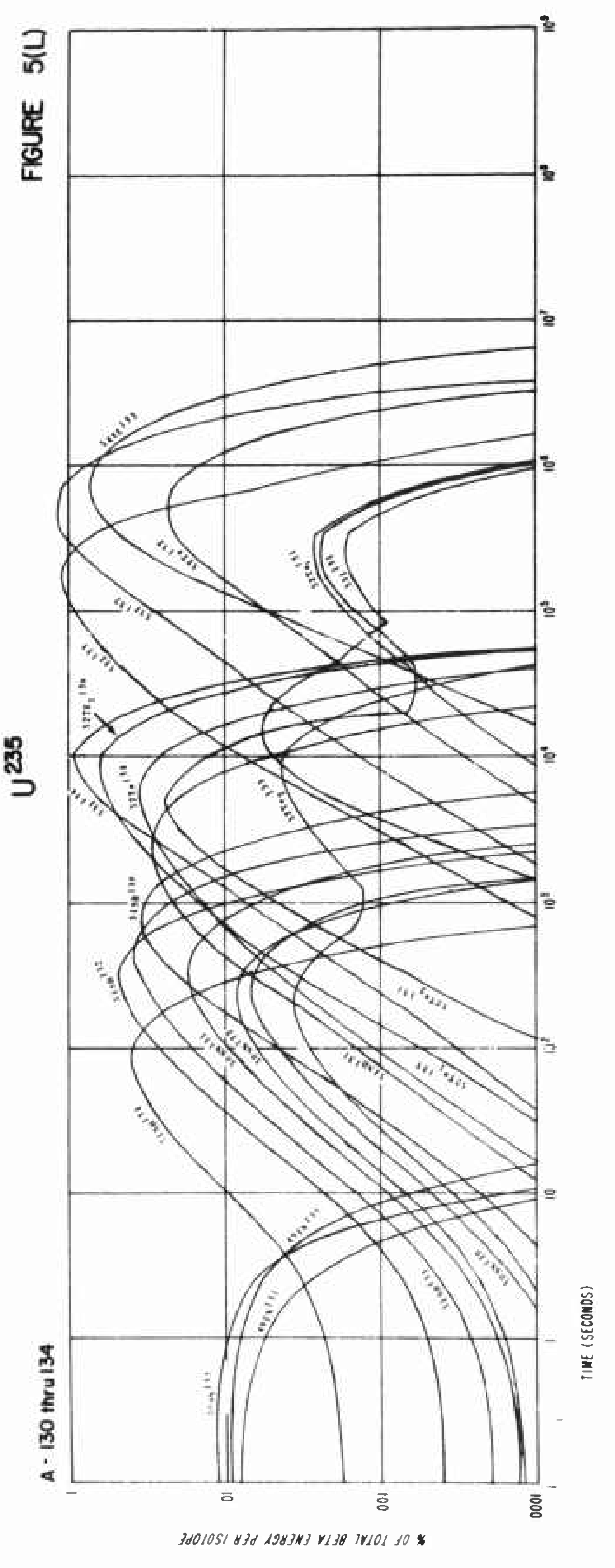


FIGURE 5(L)
U 235
A - 130 thru 134
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

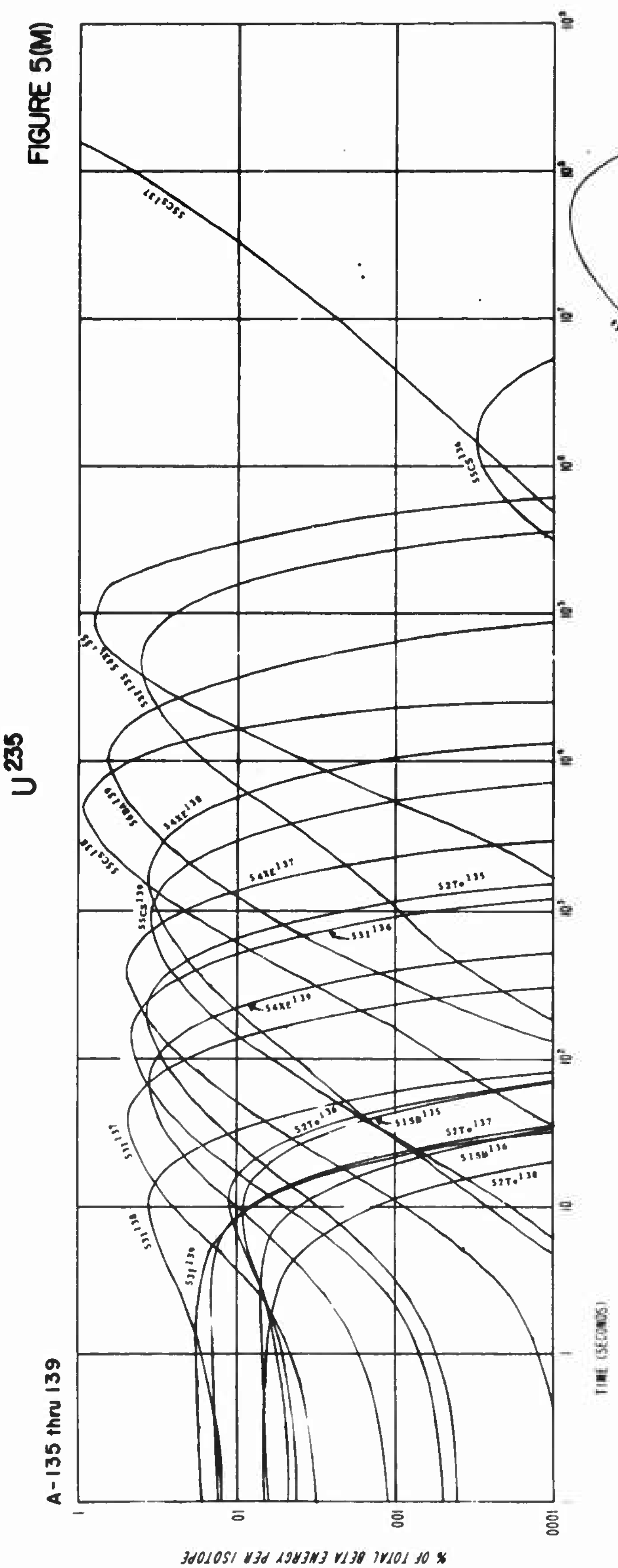


FIGURE 5(M)
U 235
A-135 thru 139
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

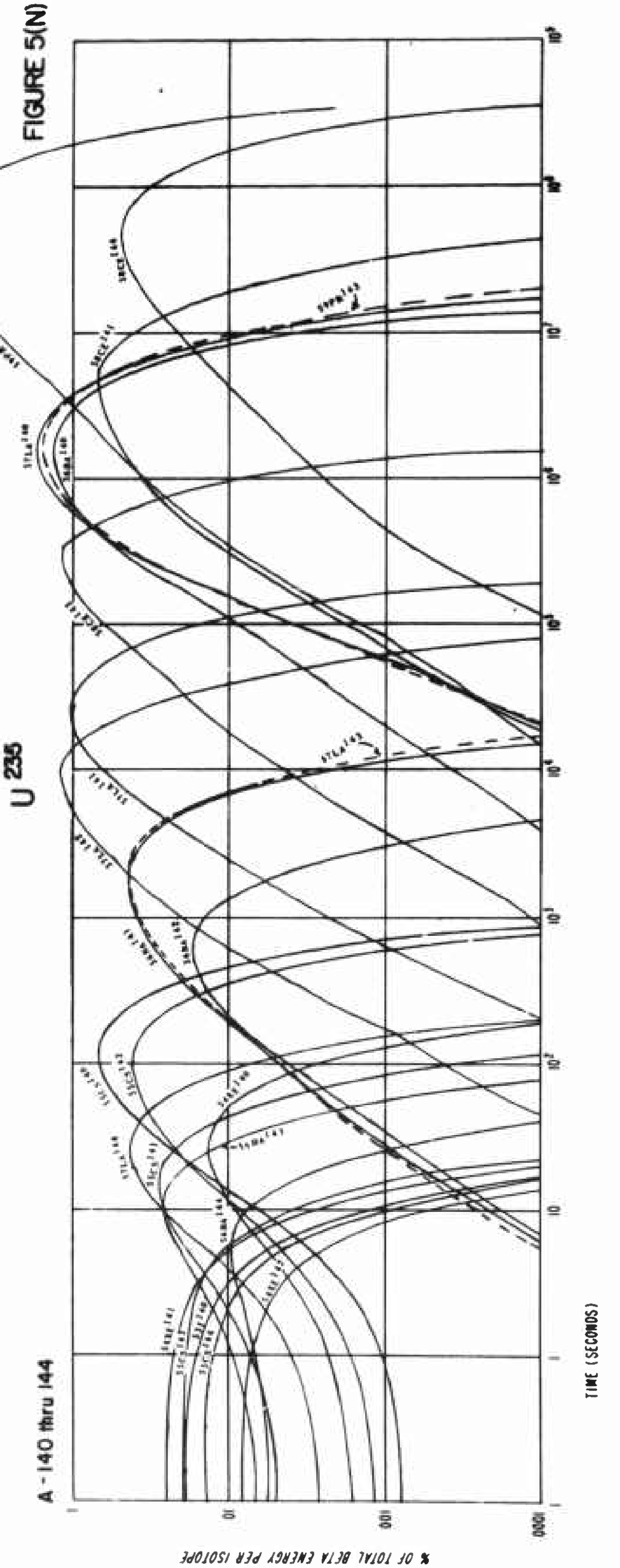


FIGURE 5(N)
U 235
A-140 thru 144
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

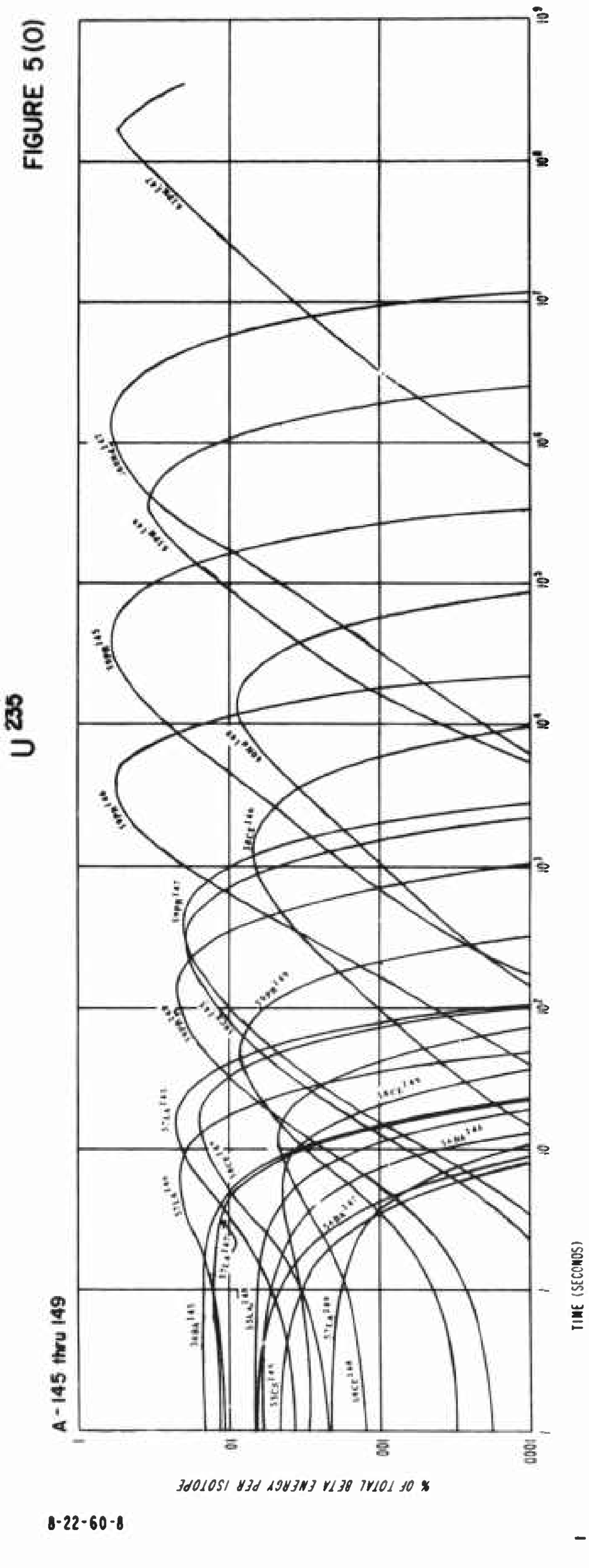


FIGURE 5 (O)
U 235
A - 145 thru 149
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

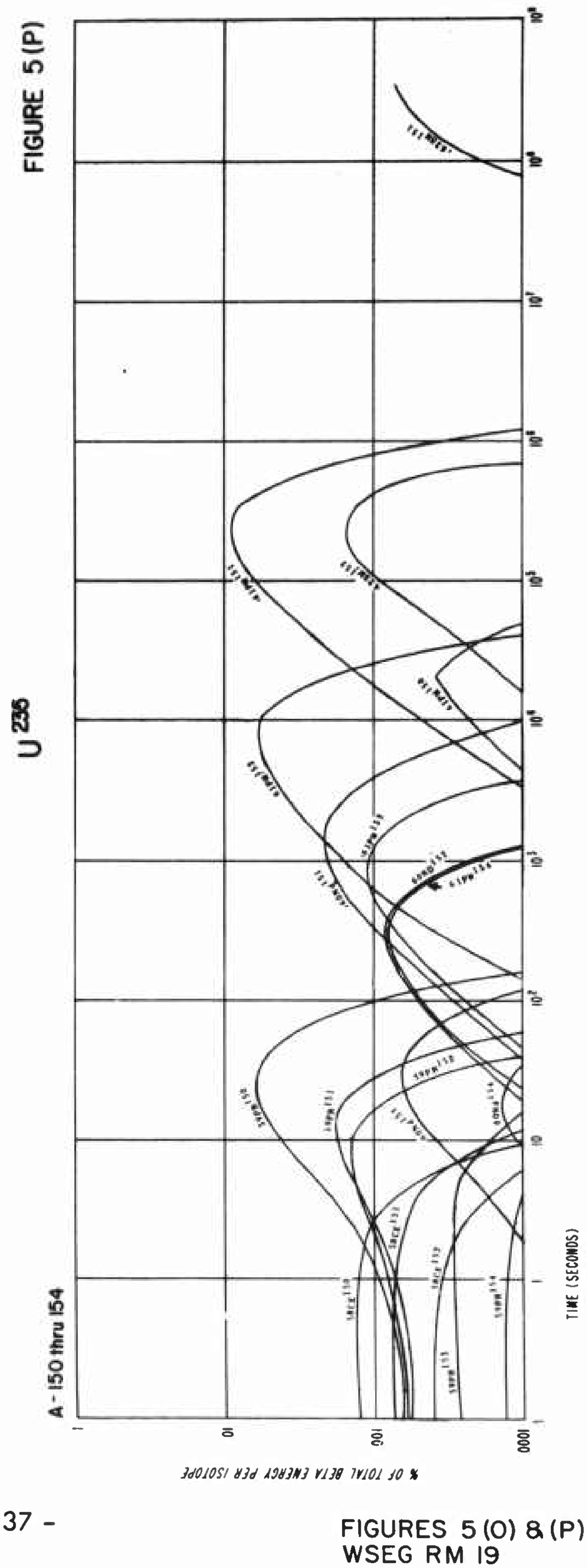


FIGURE 5 (P)
U 235
A - 150 thru 154
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

8-22-60-8

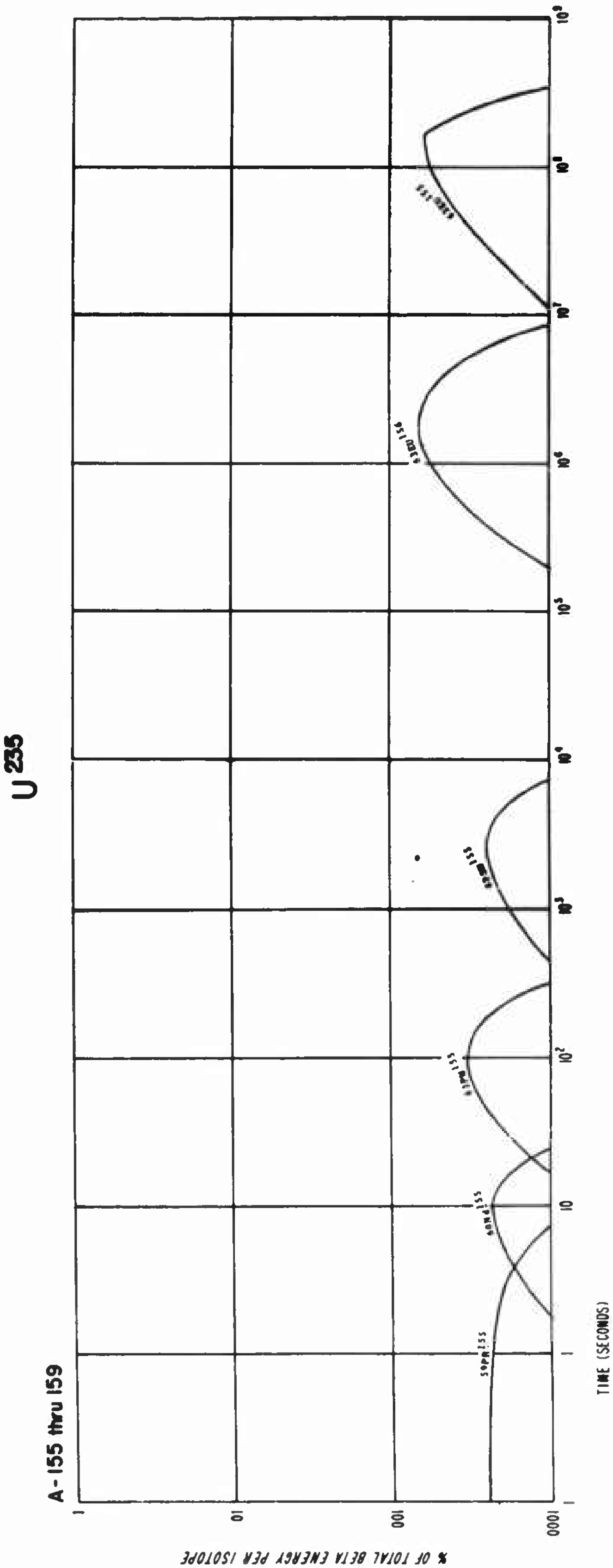


FIGURE 5(Q)
WSEG RM 19

FIGURE 6(A)

U^{238}

A - 72 thru 79

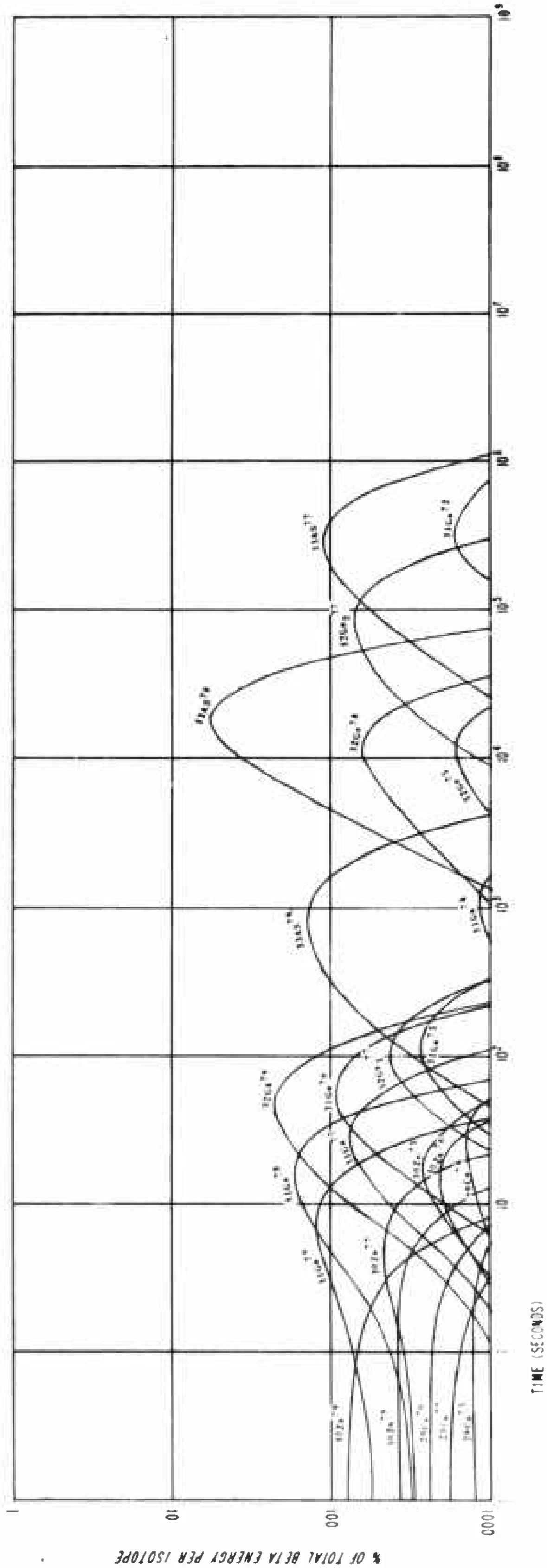
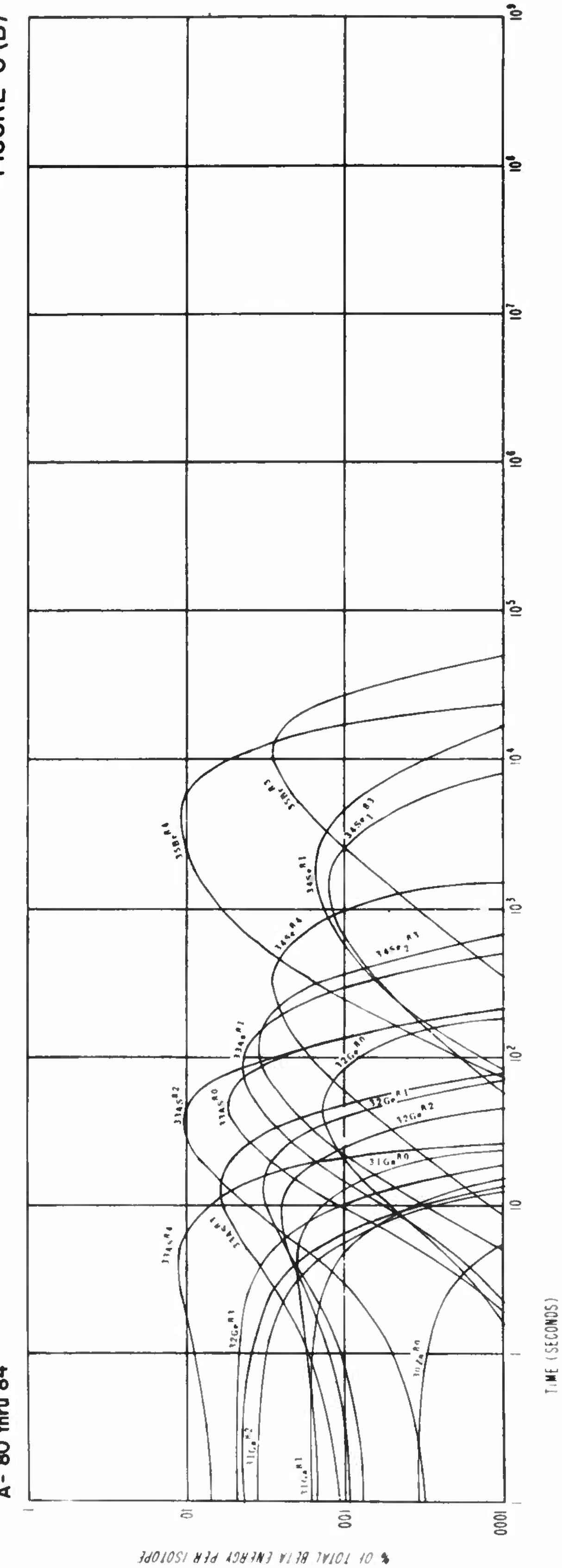


FIGURE 6 (B)

U^{238}

A - 80 thru 84



8-22-60-10

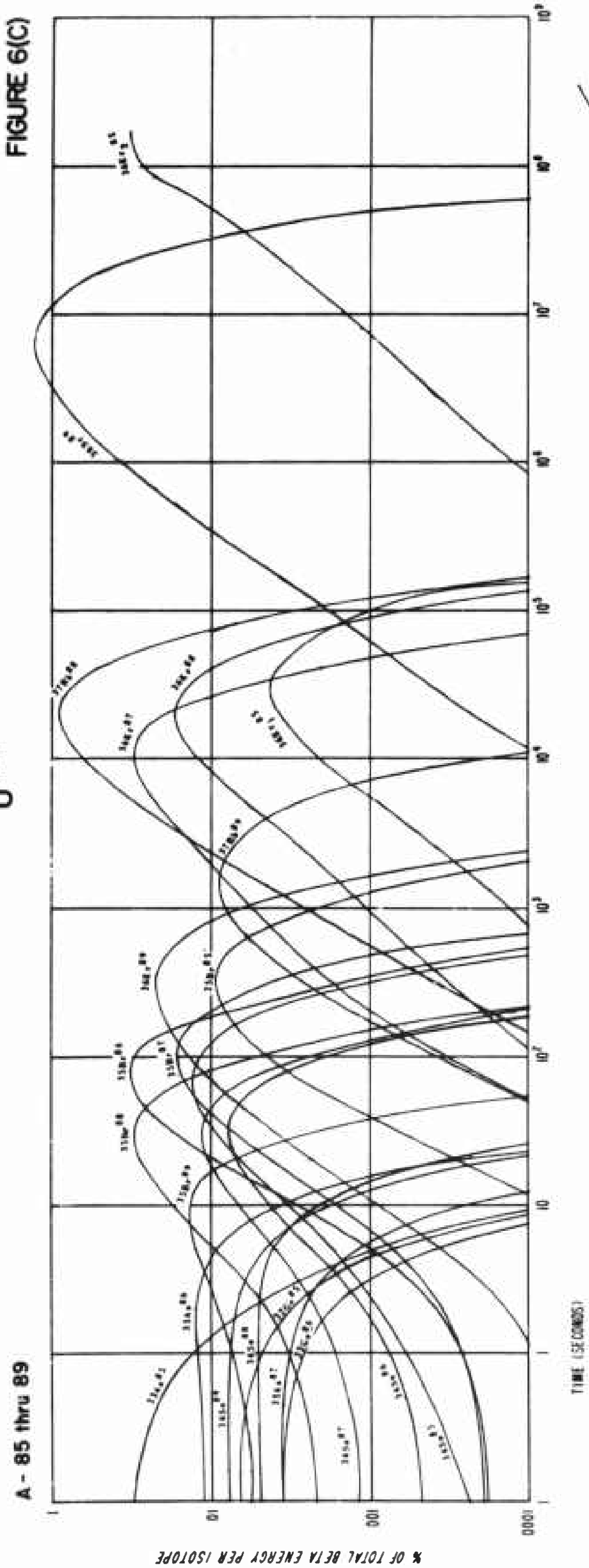


FIGURE 6(C)
U^{238}
A - 85 thru 89
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

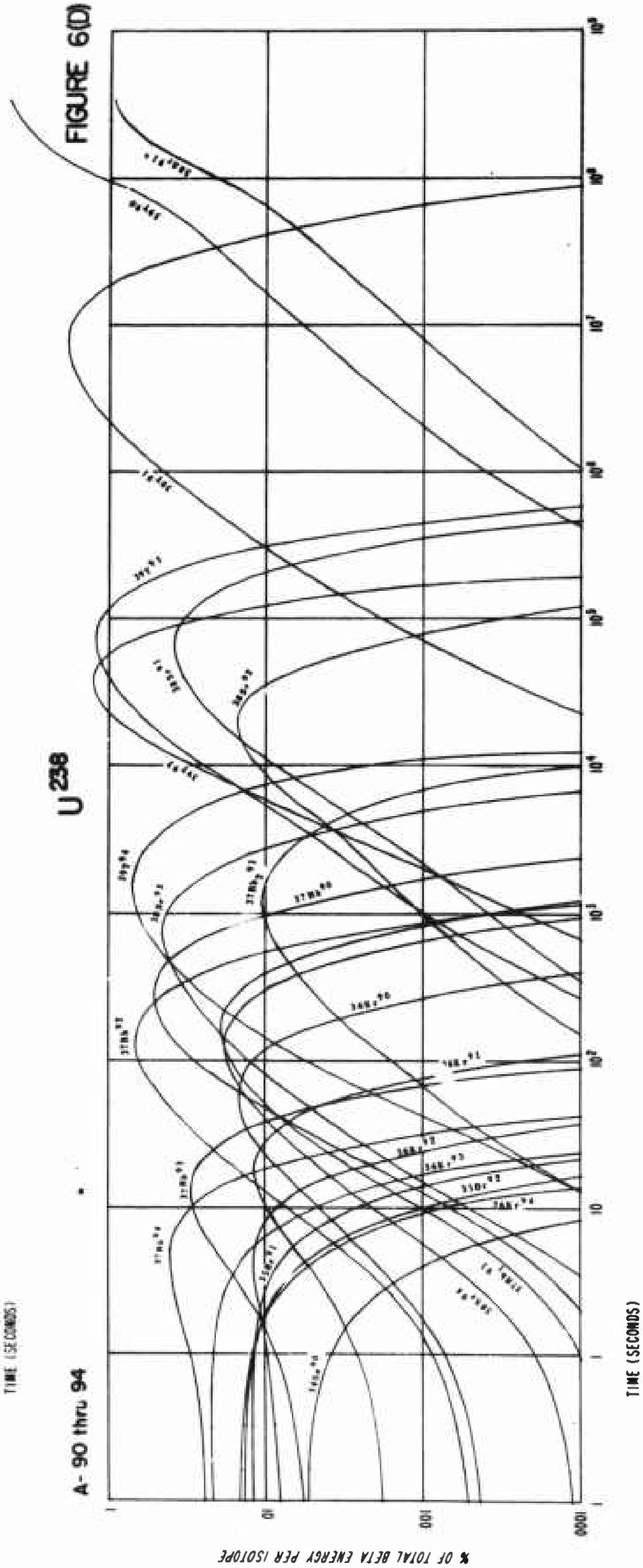


FIGURE 6(D)
U^{238}
A - 90 thru 94
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

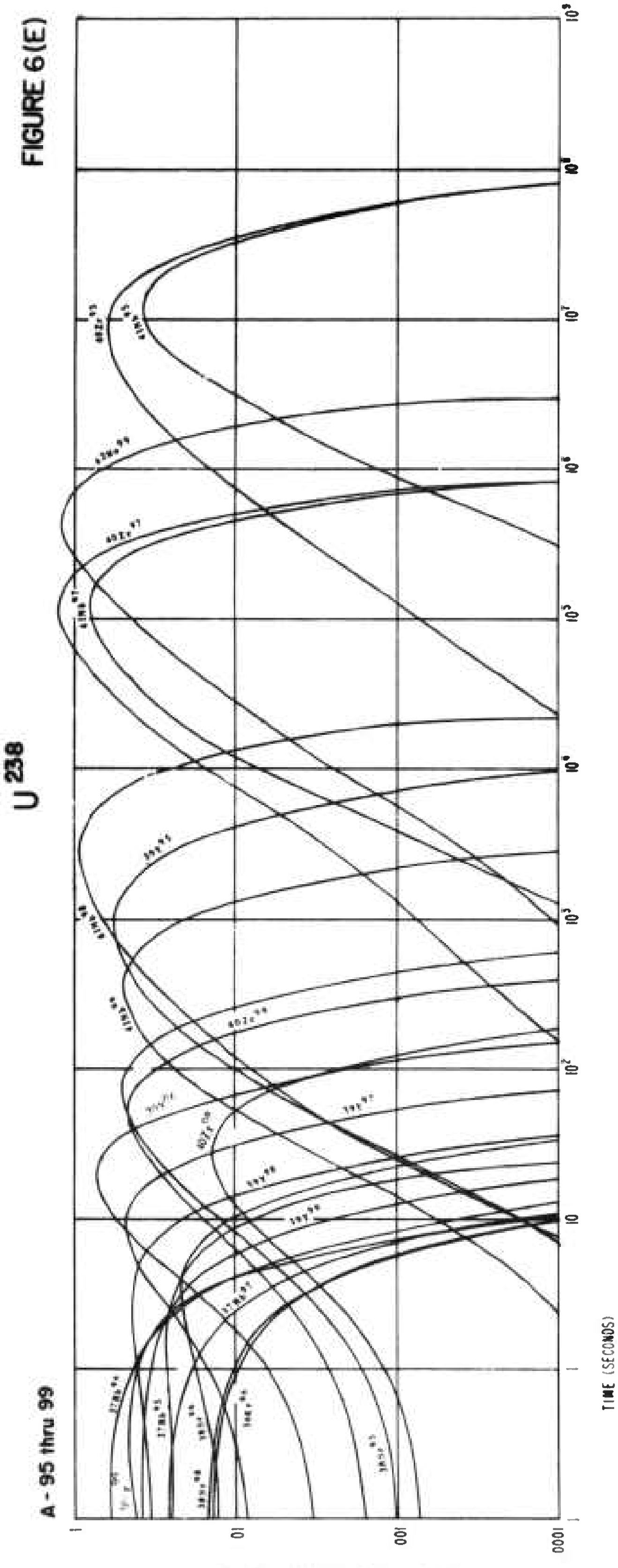


FIGURE 6(E)
U 238
A-95 thru 99
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

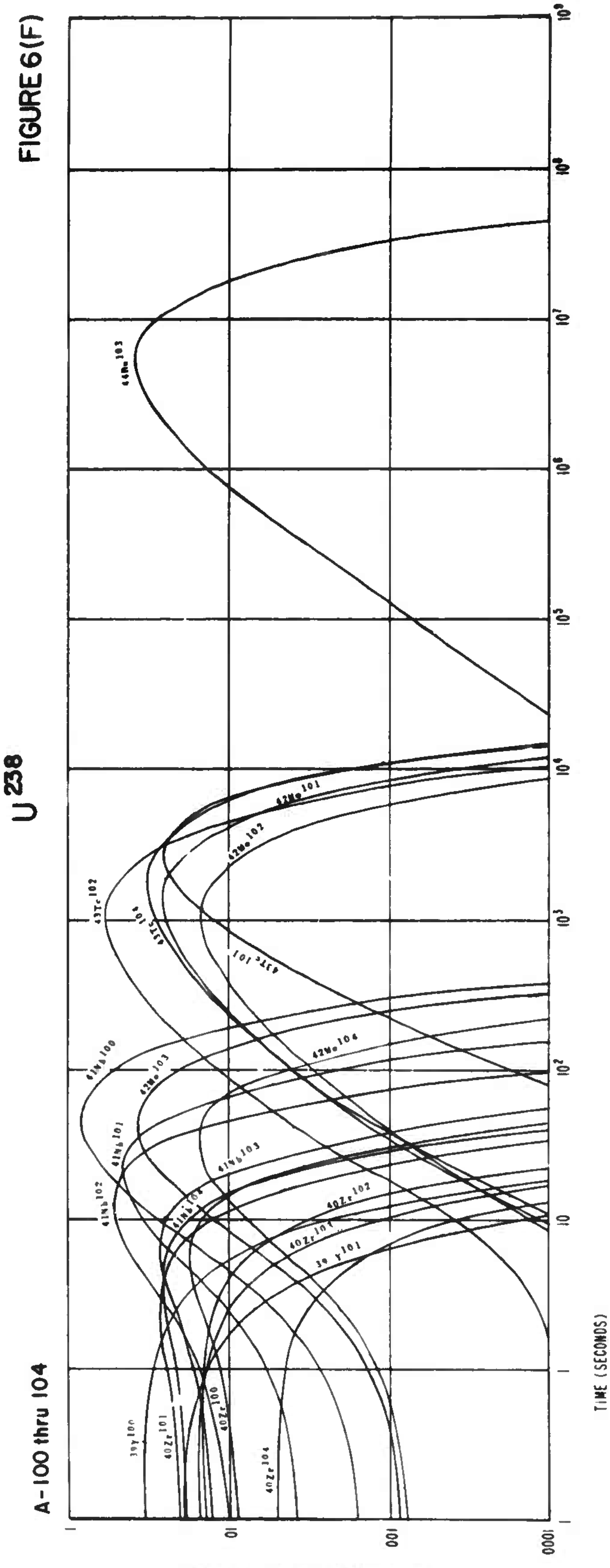


FIGURE 6(F)
U 238
A-100 thru 104
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

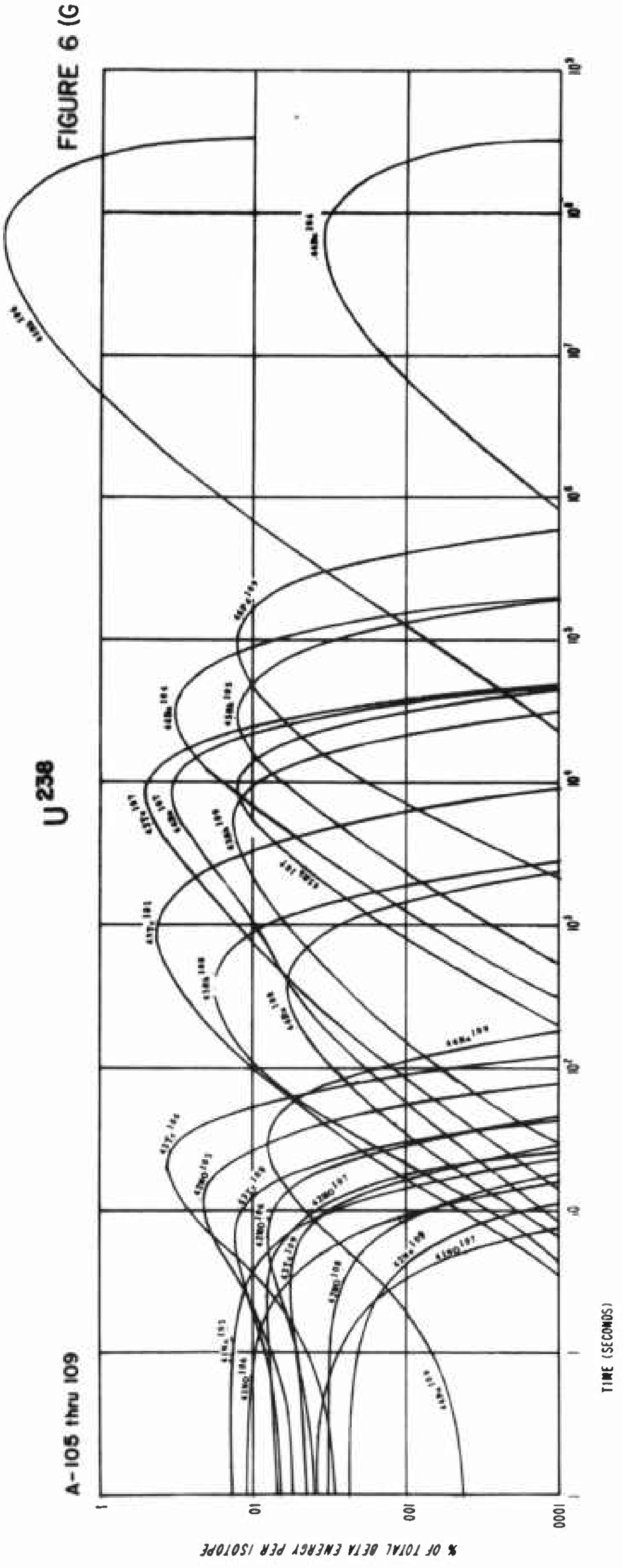


FIGURE 6 (G
U 238
A-105 thru 109
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

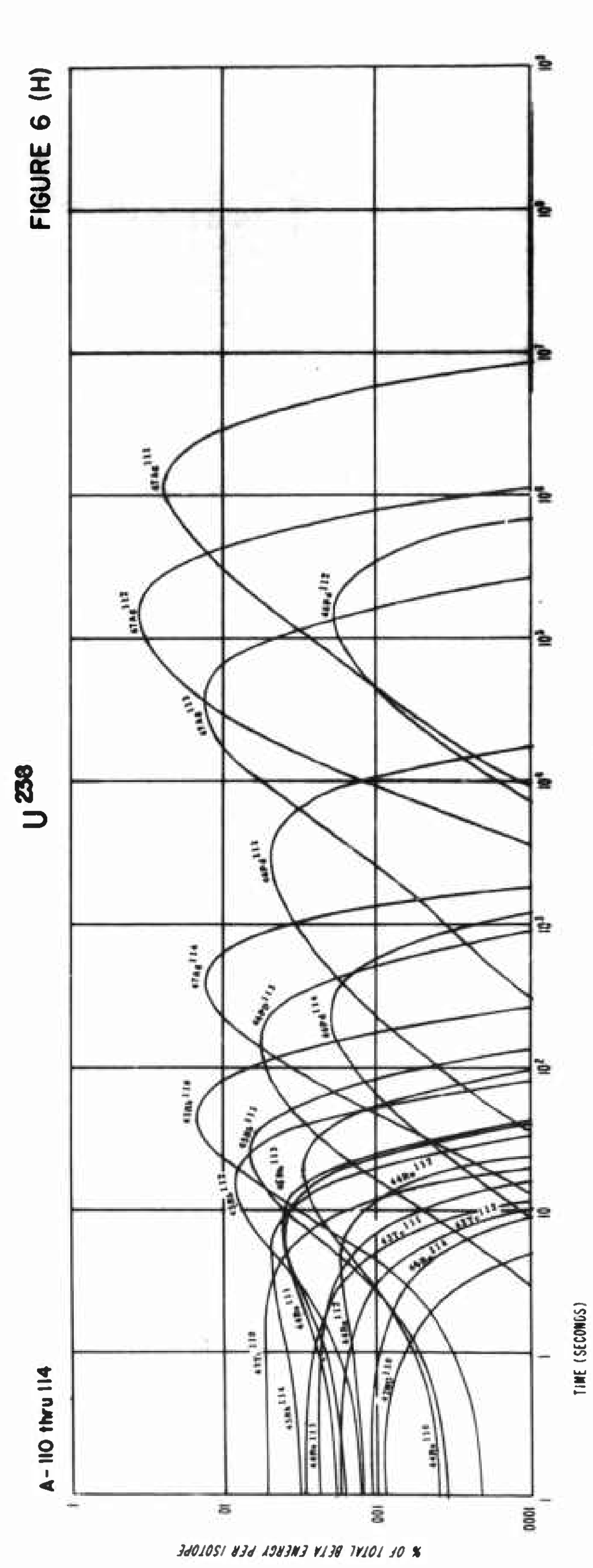


FIGURE 6 (H)
U 238
A-110 thru 114
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

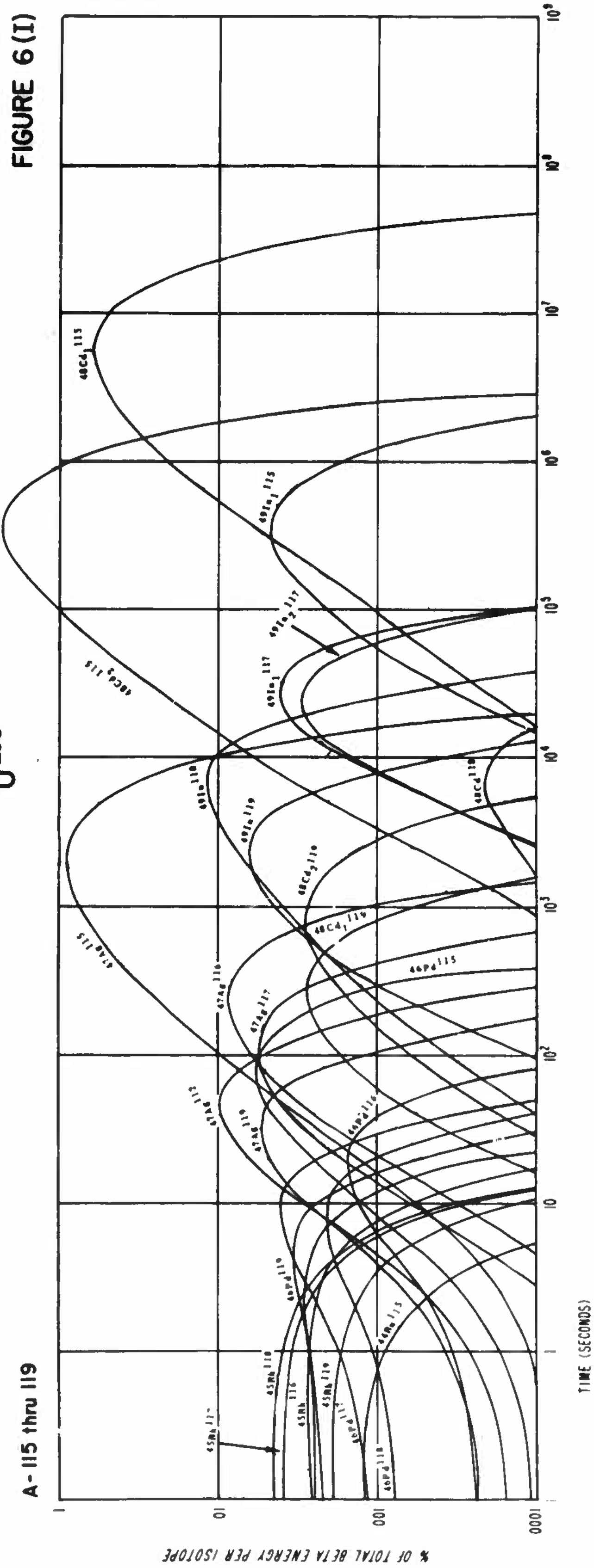


FIGURE 6 (I)
U238
A-115 thru 119
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

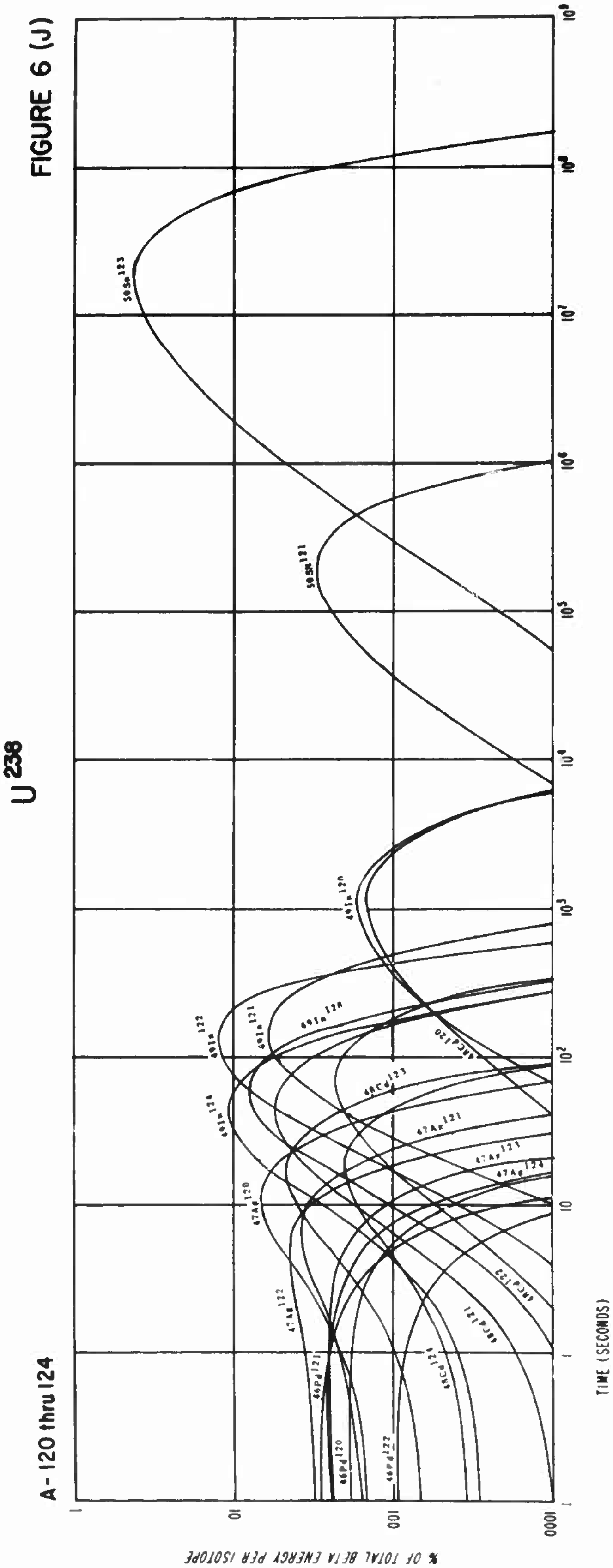


FIGURE 6 (J)
U238
A-120 thru 124
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

FIGURE 6 (K)

U^{238}

A - 125 thru 129

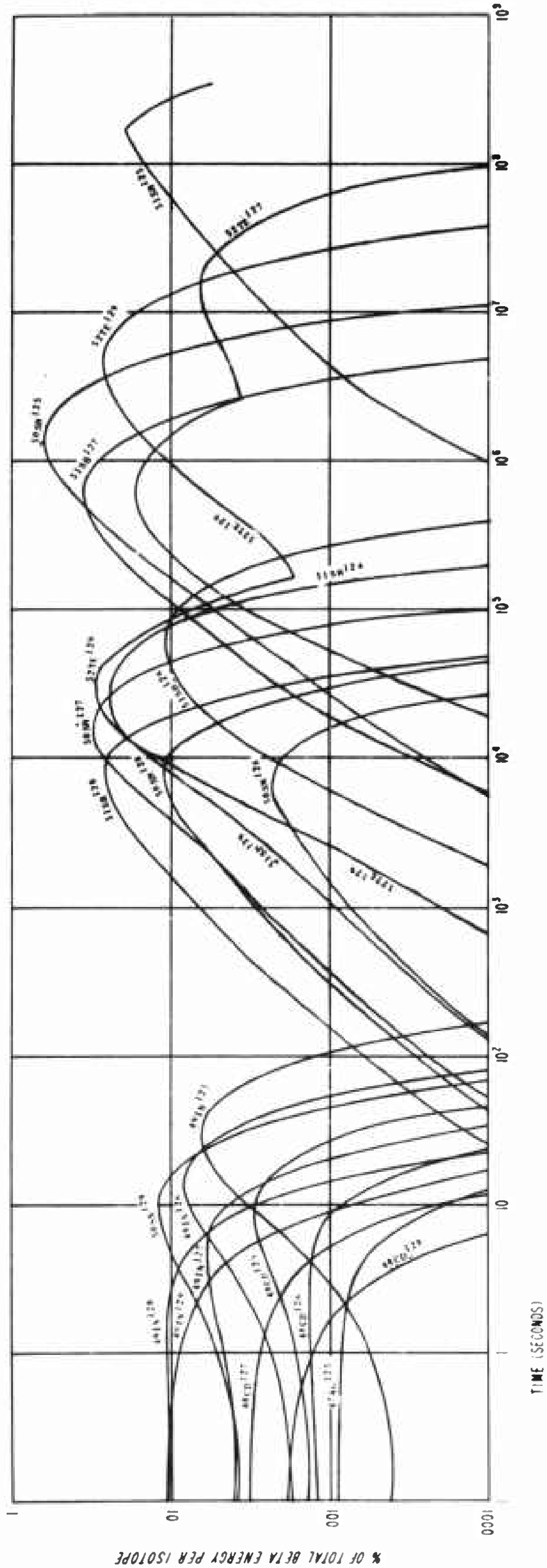
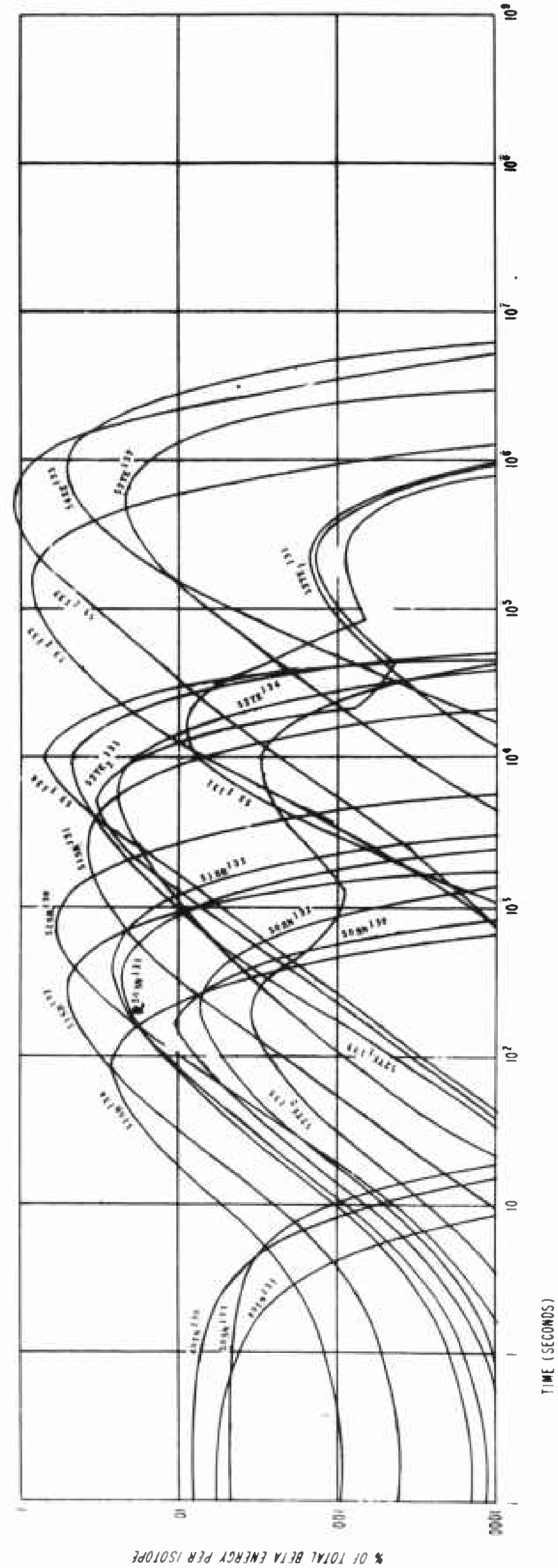


FIGURE 6 (L)

U^{238}

A - 130 thru 134



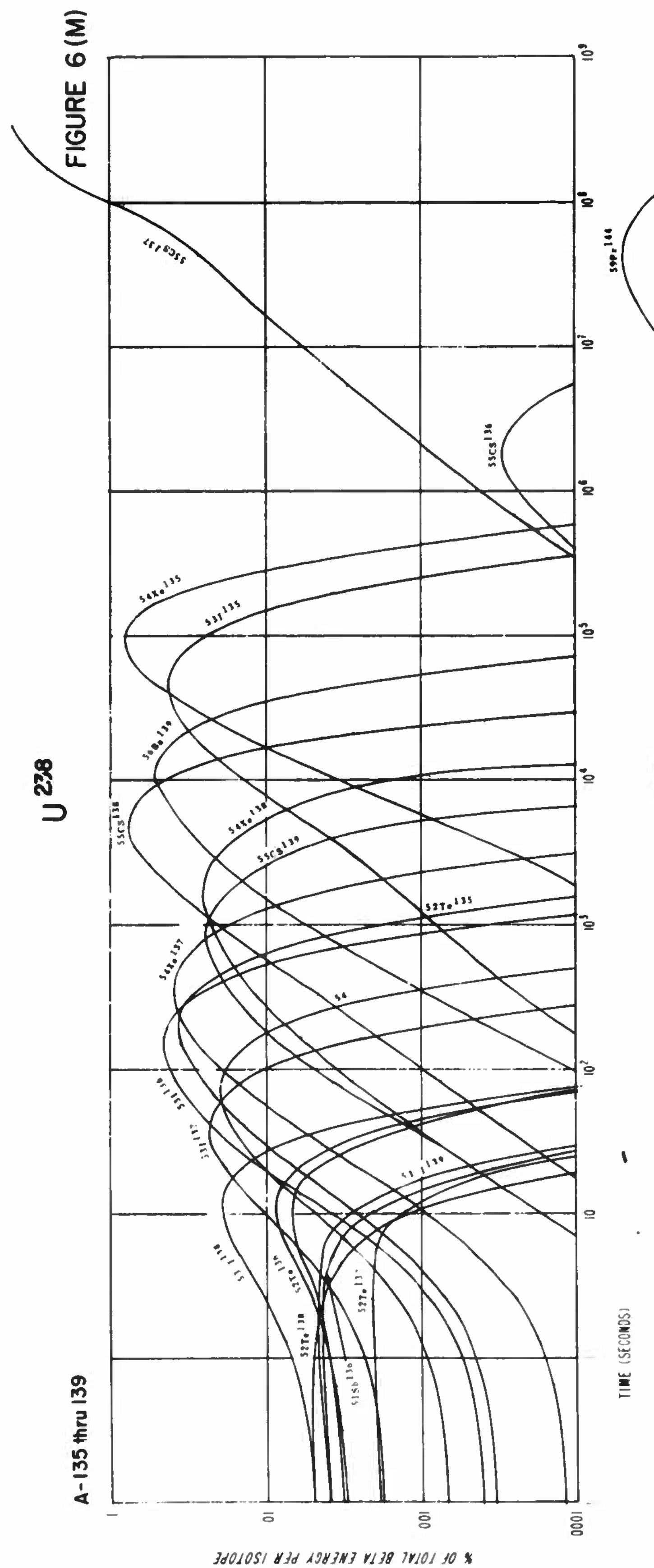


FIGURE 6(M)
U 238
A-135 thru 139
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

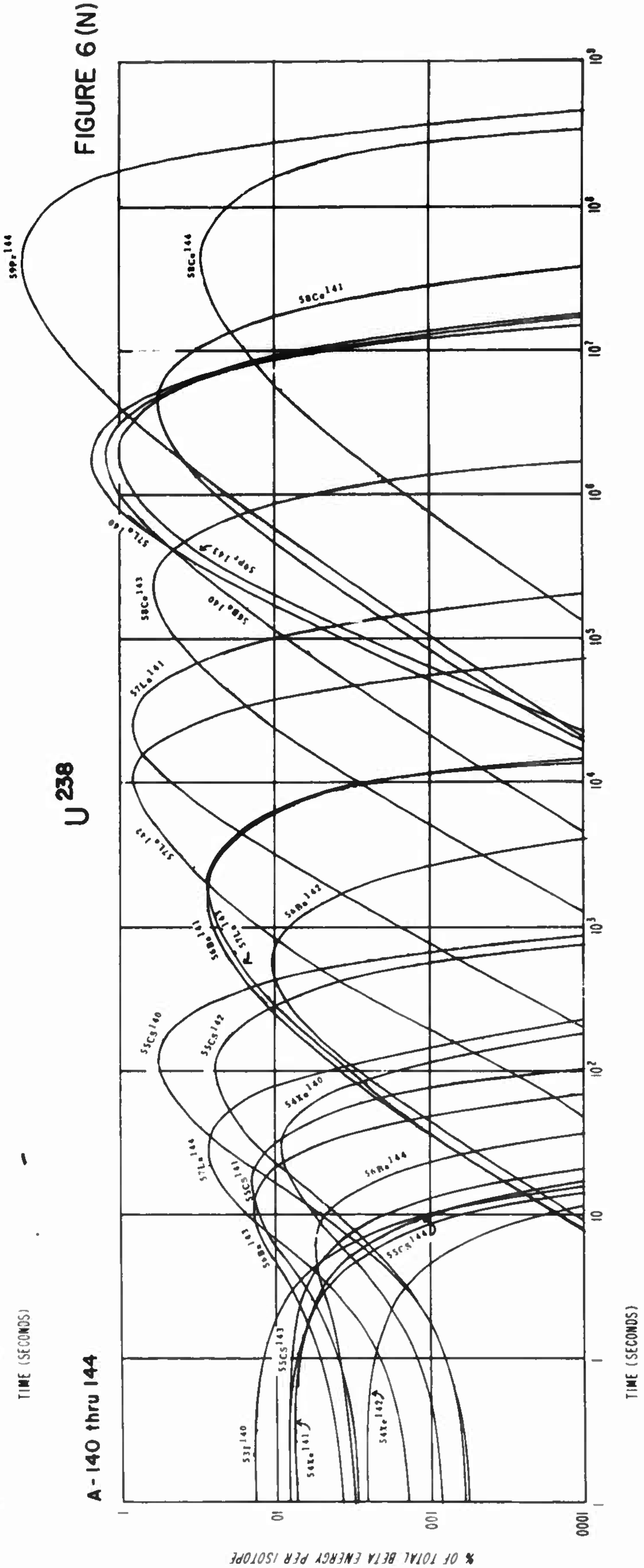


FIGURE 6(N)
U 238
A-140 thru 144
TIME (SECONDS)
% OF TOTAL BETA ENERGY PER ISOTOPE

FIGURE 6 (O)

U^{238}

A-145 thru 149

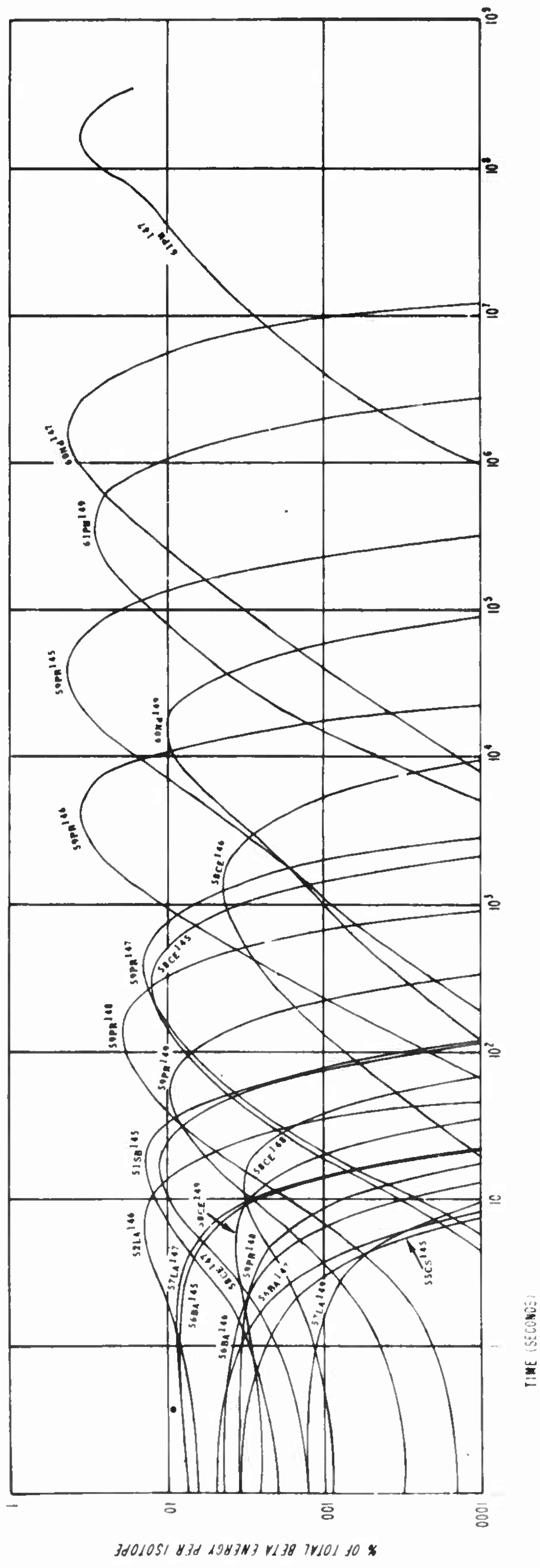
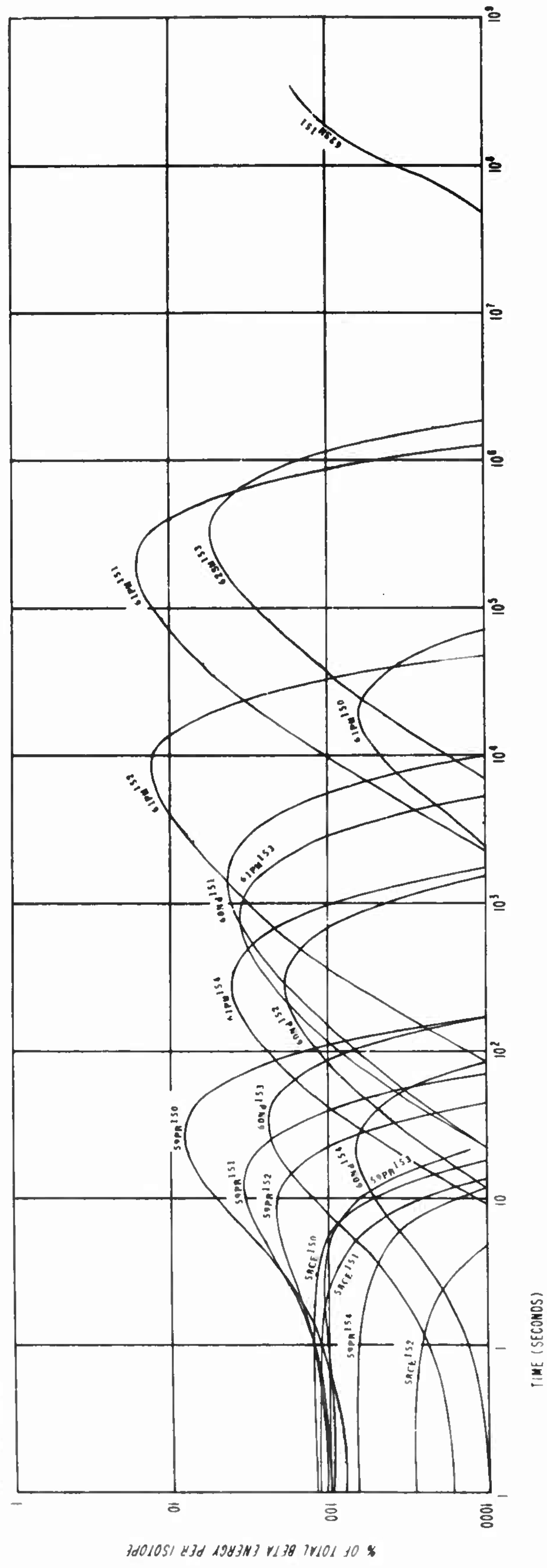


FIGURE 6 (P)

U^{238}

A-150 thru 154



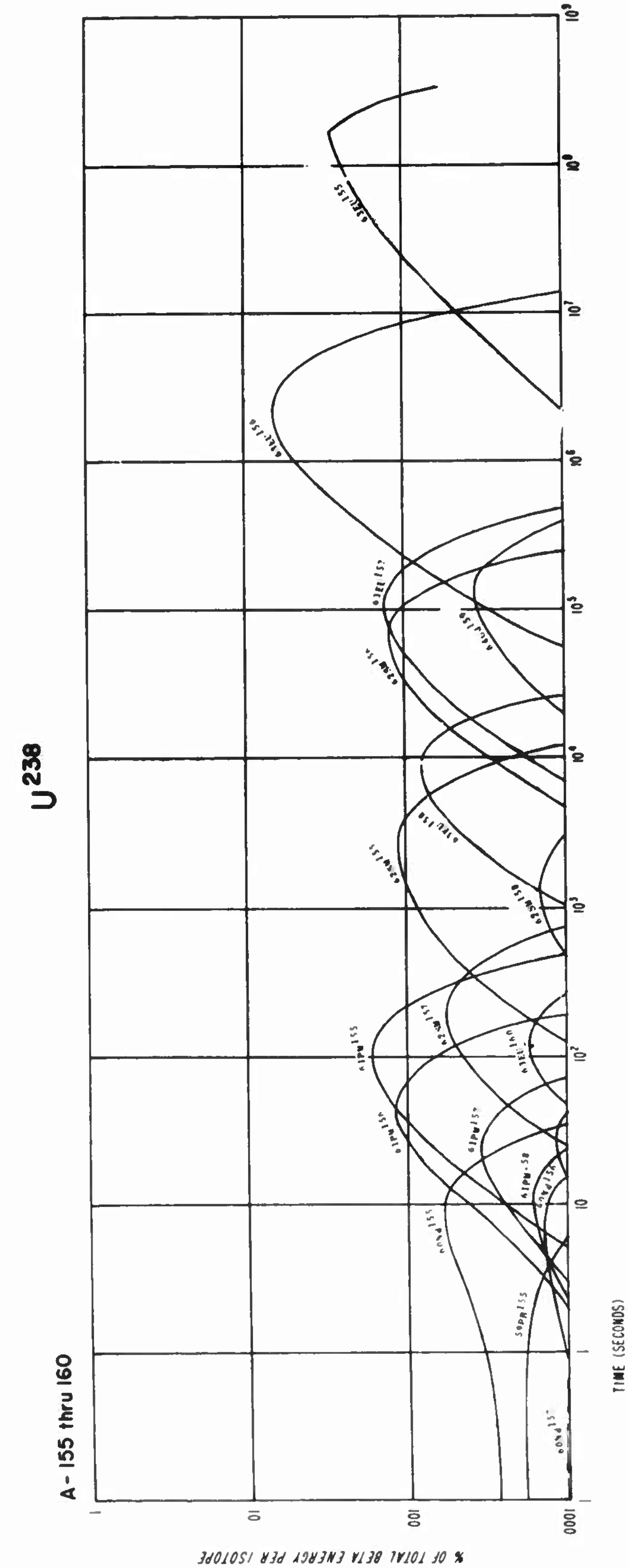
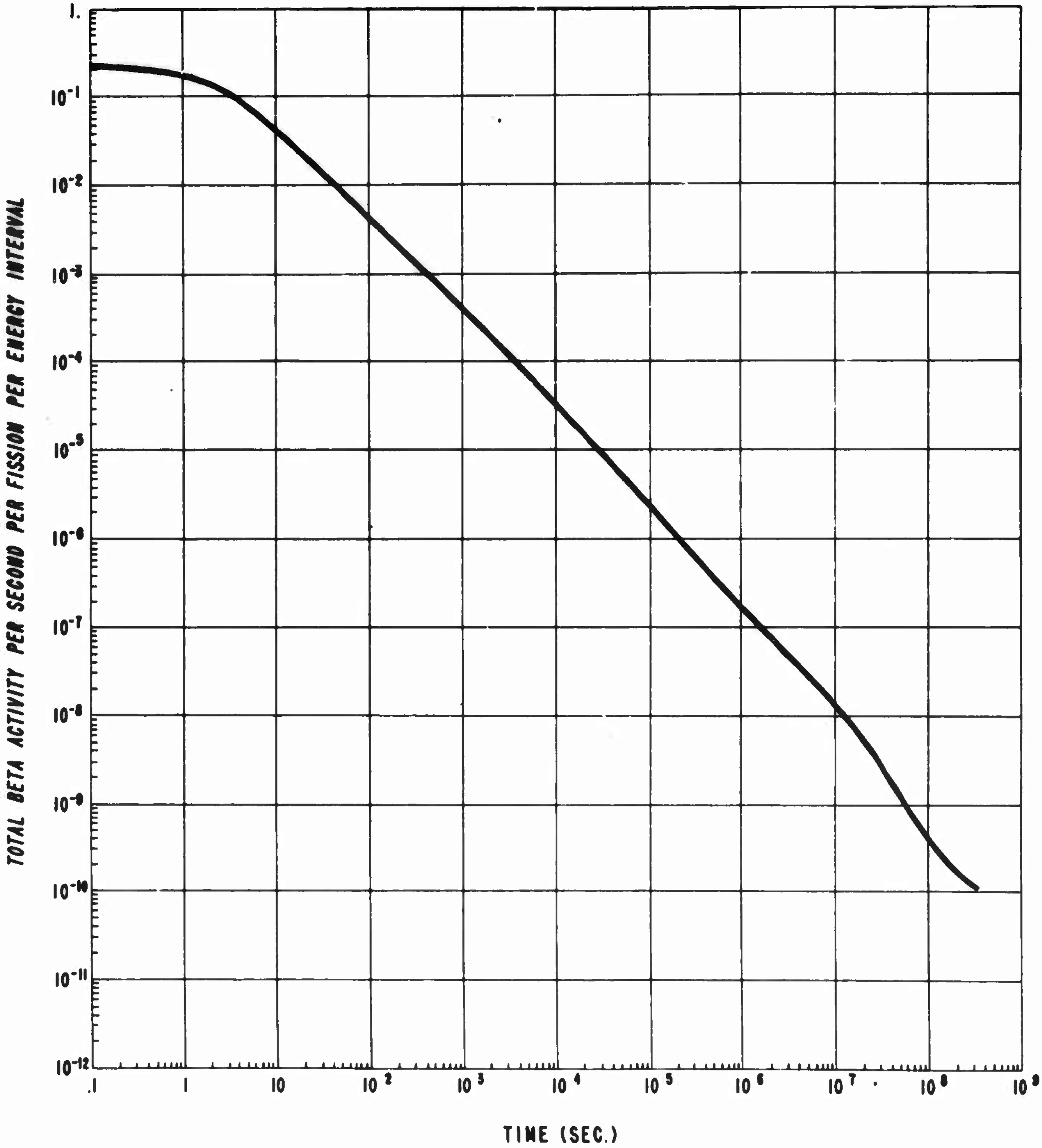


FIGURE 6 (Q)
WSEG RM 19

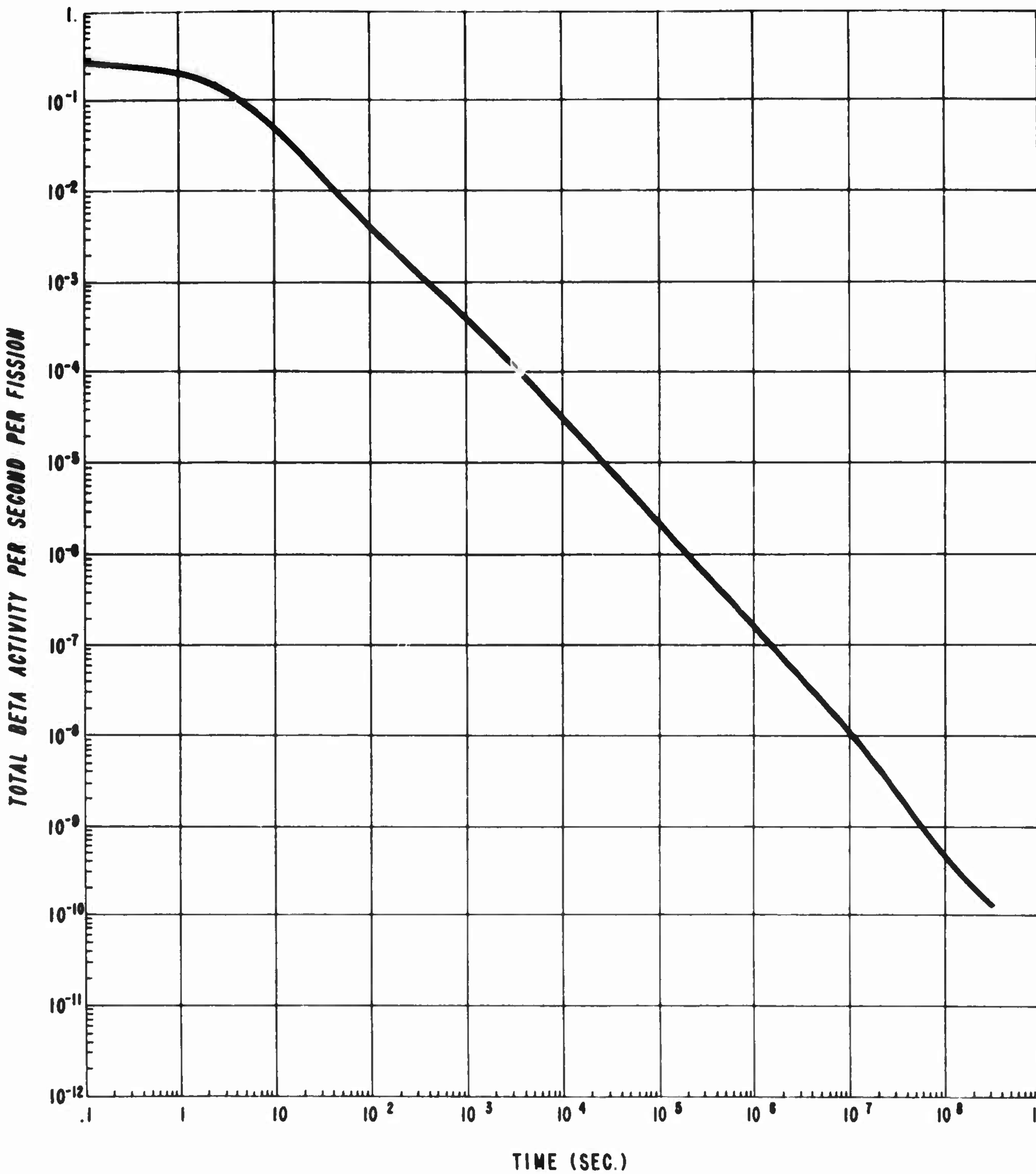
U 235



8-22-60-19

FIGURE 7
WSEG RM 19

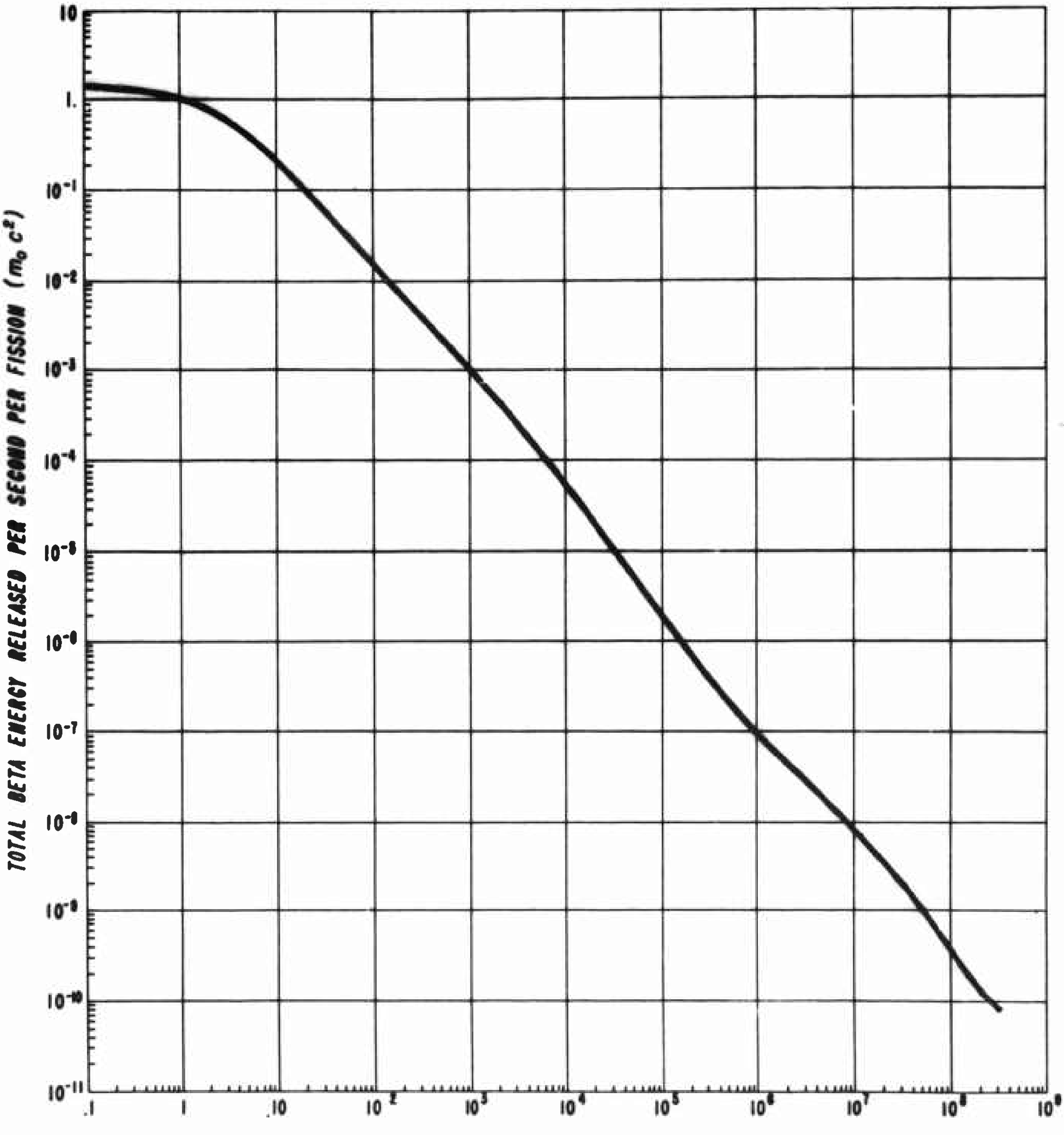
U 238



8-22-60-20

FIGURE 8
WSEG RM 19

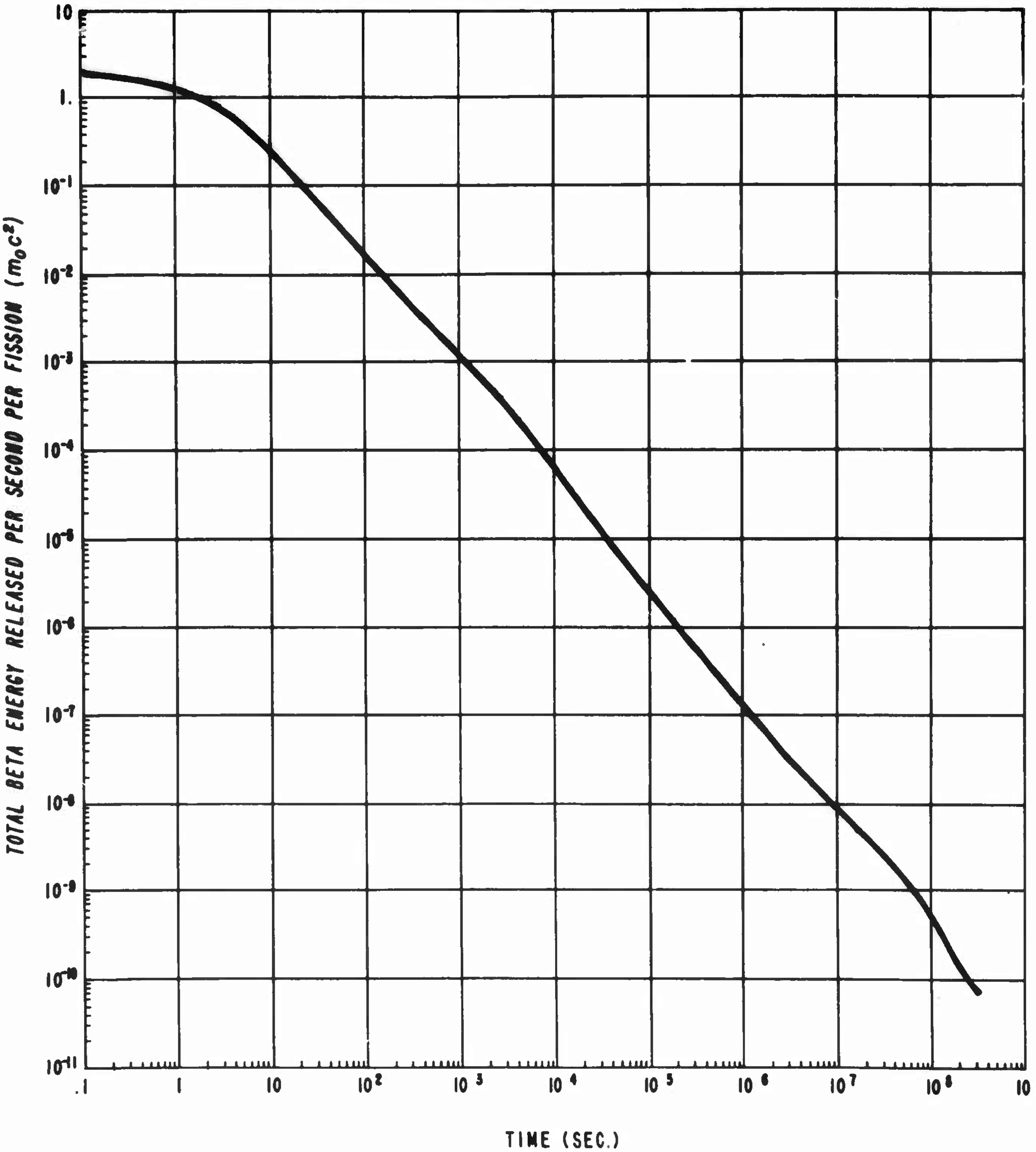
U 235



8-22-60-21

FIGURE 9
WSEG RM 19

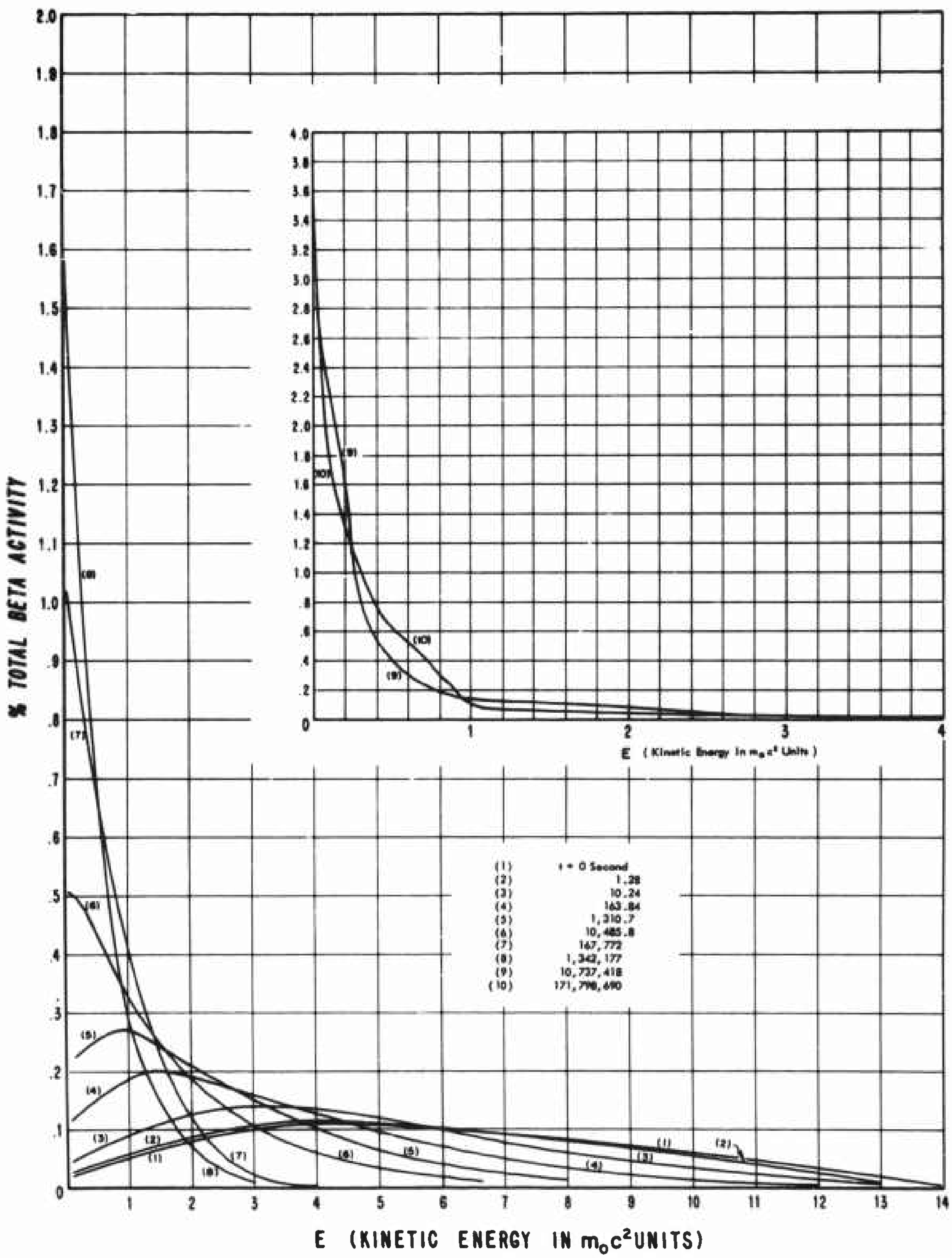
U^{238}



8-22-60-22

FIGURE 10
WSEG RM 19

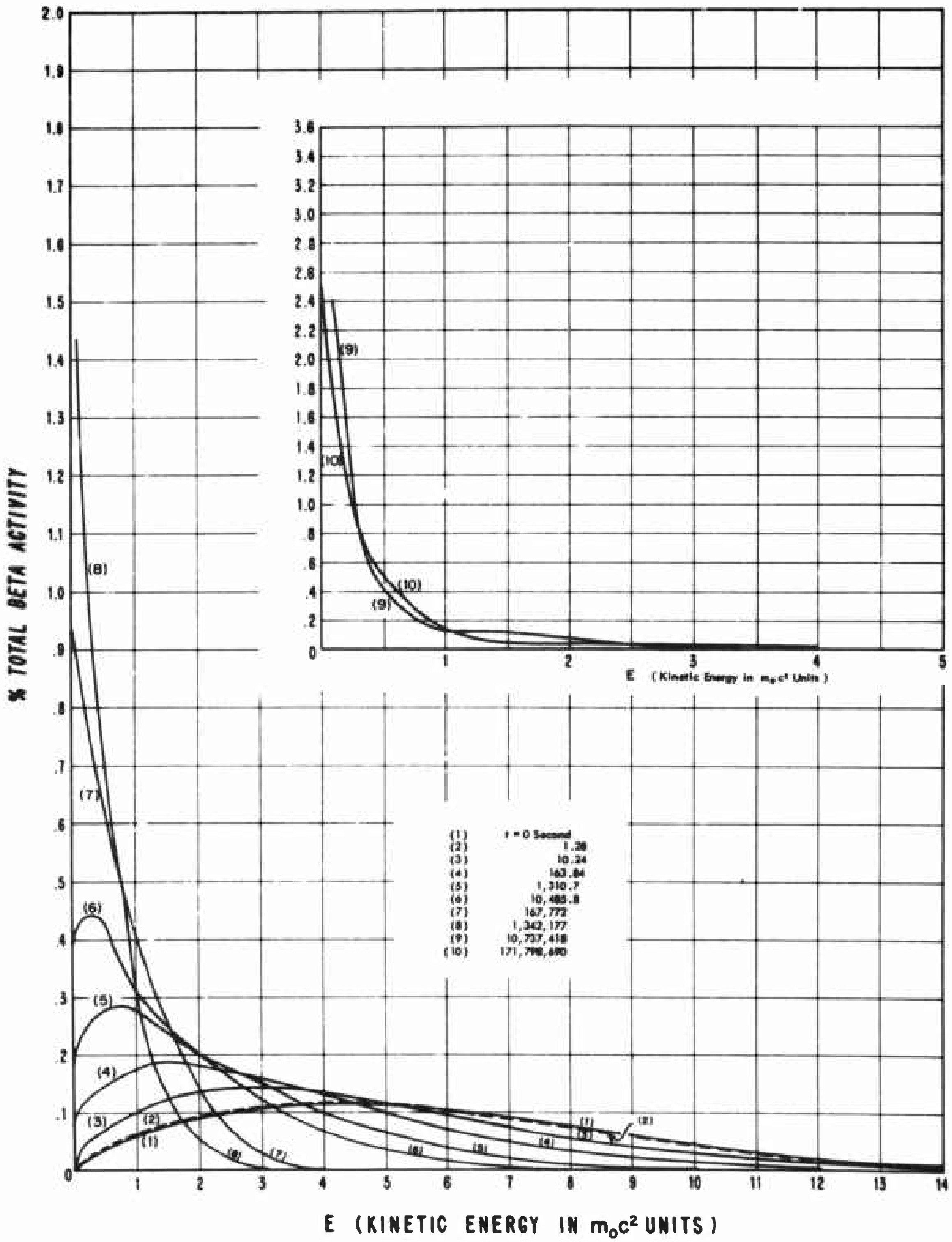
U 238



8-22-60-23

FIGURE 11
WSEG RM 19

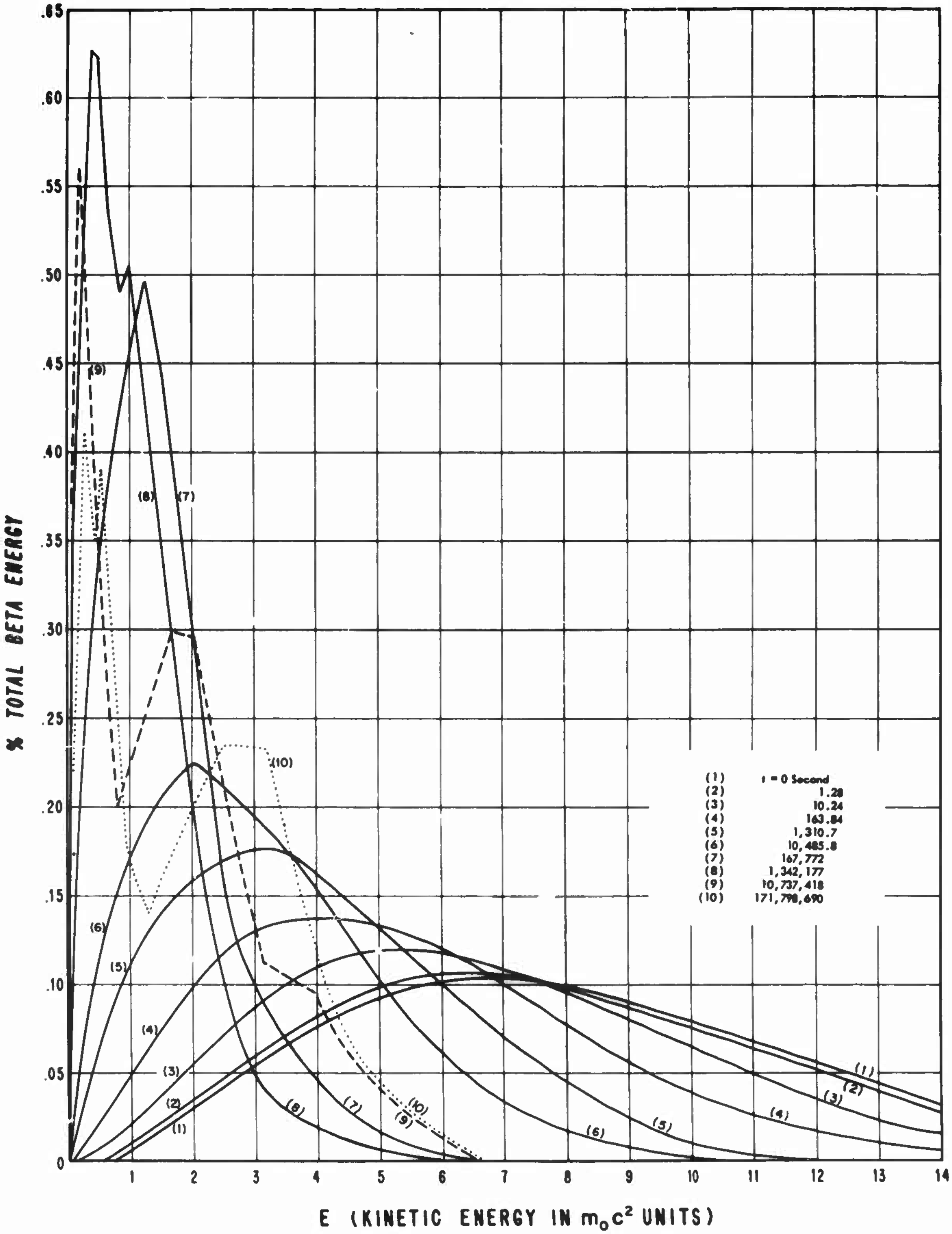
U^{235}



8-22-60-24

FIGURE 12
WSEG RM 19

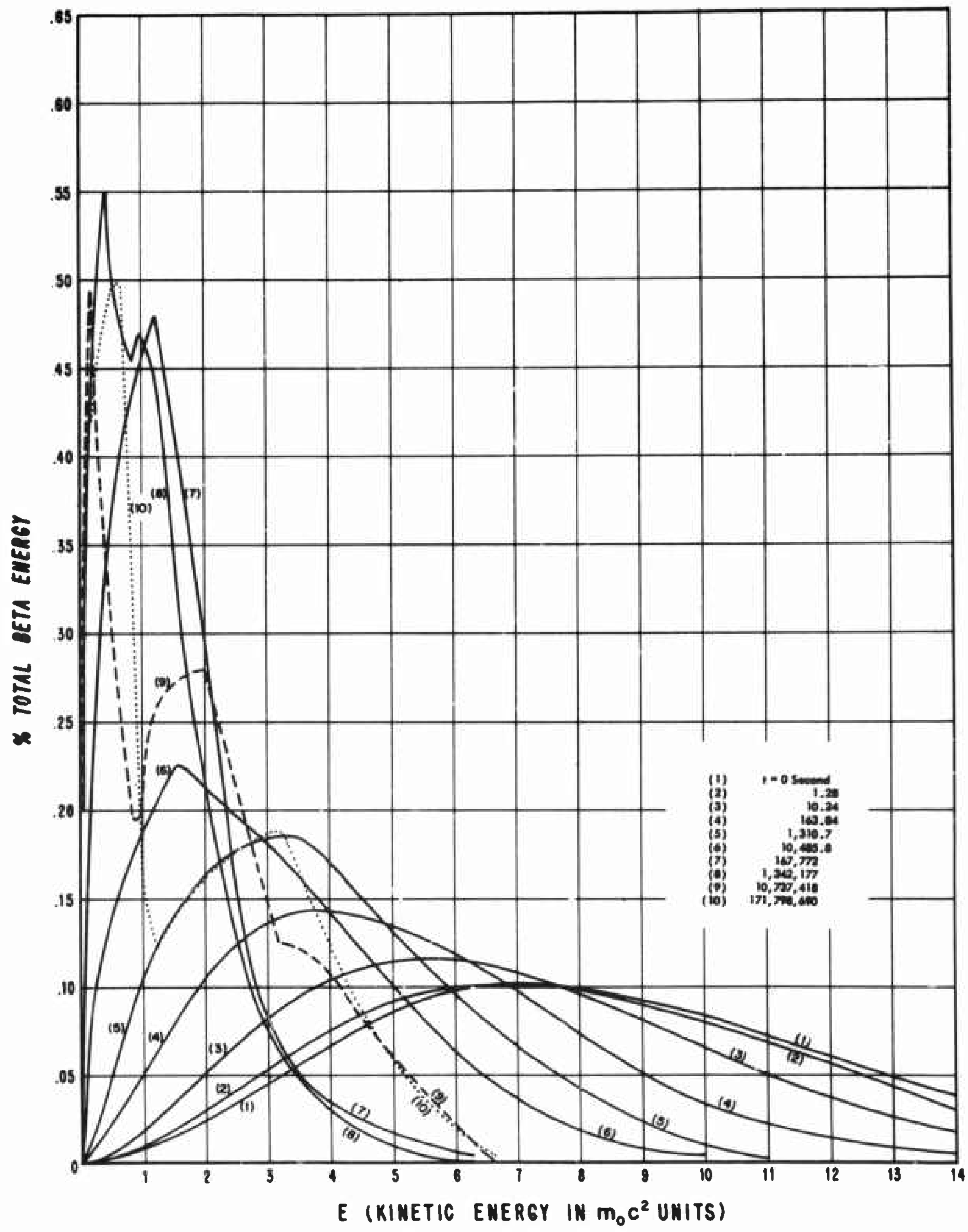
U 235



8-22-60-25

FIGURE 13
WSEG RM 19

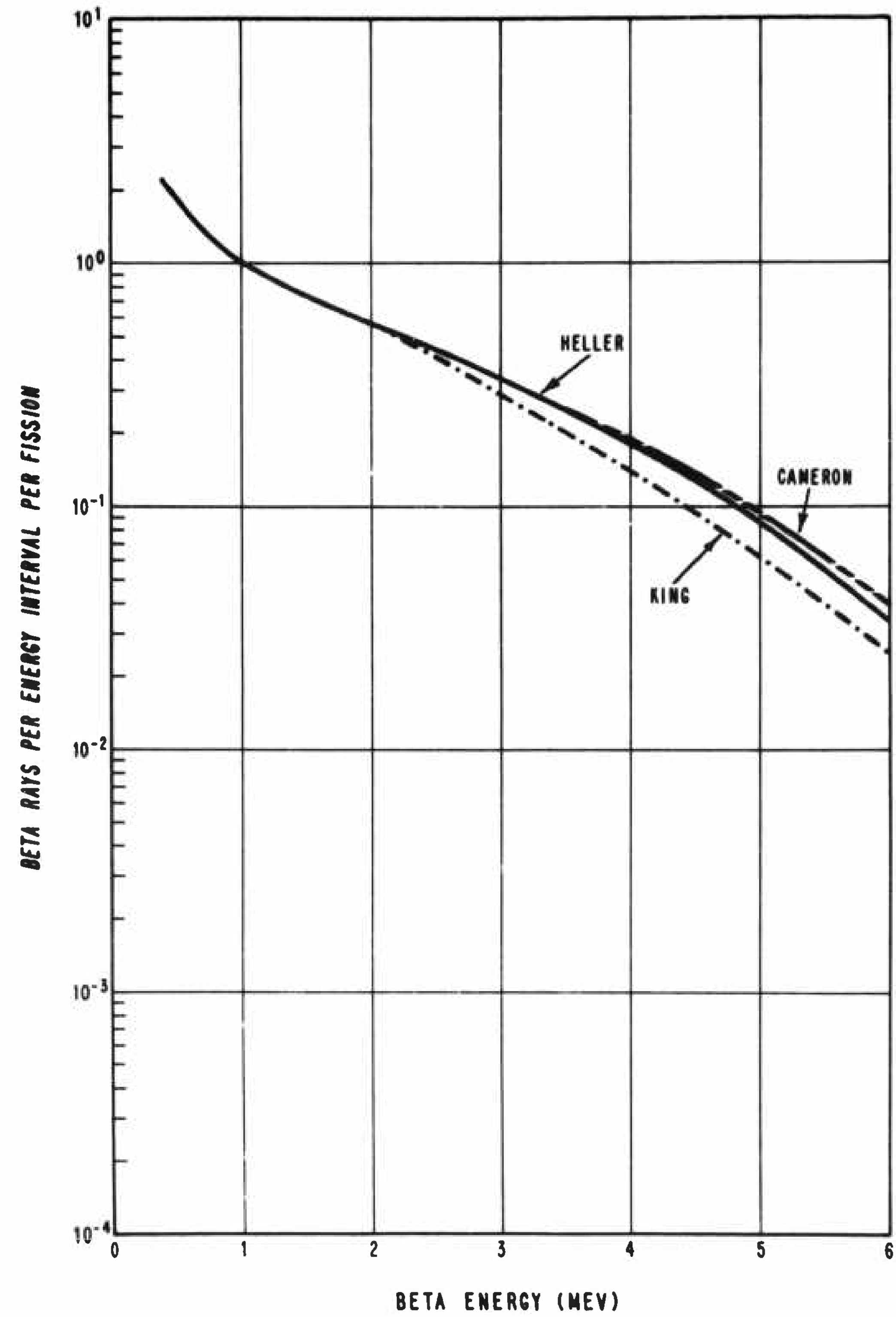
U^{238}



8-22-60-26

FIGURE 14
WSEG RM 19

NUMBER OF BETA RAYS PER FISSION PER ENERGY INTERVAL U^{235}



9-28-60-1

FIGURE 15
WSEG RM 19

UNCLASSIFIED

UNCLASSIFIED